STOPPING WATER POLLUTION AT ITS SOURCE

MISA

Municipal/Industrial Strategy for Abatement

MONITORING COSTS AND THEIR IMPLICATIONS FOR DIRECT DISCHARGERS IN THE ONTARIO PULP AND PAPER INDUSTRY

FINAL REPORT

AUGUST 1989

Environment Ontario

Jim Bradley
Minister

ISBN 0-7729-5997-8

MUNICIPAL-INDUSTRIAL STRATEGY FOR ABATEMENT (MISA)

MONITORING COSTS AND THEIR IMPLICATIONS FOR DIRECT DISCHARGERS IN THE ONTARIO PULP AND PAPER INDUSTRY

FINAL REPORT

Socio-Economic Section
Policy and Planning Branch
Corporate Resources Division

August 1989

COPYRIGHT: Queen's Printer for Ontario, 1989

TABLE OF CONTENTS

	Page No.
TABLE OF CONTENTS	i
LIST OF TABLES	ii
ABSTRACT	iv
1. BACKGROUND AND PURPOSE OF REPORT	1
1.1 MISA Objectives	1
1.2 Sectors Affected by MISA	1
1.3 Effluent Monitoring Regulation for Pulp and Paper Sector	3
1.4 Purpose and Objectives of Present Report.	5
1.5 Cost Estimation Methods	5
2. MONITORING COST ESTIMATES	7
2.1 Regulation Requirements	7
2.2 Sampling Requirements	8
2.3 Flow Measurement	16
2.4 Chemical Analyses	18
2.5 Toxicity Testing	23
2.6 Reporting	27
2.7 Intake Water	29
2.8 Total Estimated Costs of the MISA Pulp and Paper Sector Monitoring Requirements	32
2.9 Alternative Estimates of Monitoring Costs	38
3. ECONOMIC EFFECTS AND IMPLICATIONS OF MONITORING COSTS	42
3.1 Industry Performance	42
3.2 Analytical Procedures	45
3.3 Economic and Financial Implications	47
4. CONCLUSIONS AND RECOMMENDATIONS	54
4.1 Conclusions	54
4.2 Recommendations	55
REFERENCES	56

LIST OF TABLES

Table	Title	Page No.
1.1	Industrial Sectors Subject to MISA Direct Discharge Regulations	2
1.2	Ontario Pulp and Paper Mills Subject to the MISA Monitoring Regulation	4
2.1	Sampling and Refrigeration Devices Currently Installed and Cost Estimates for Additional Sampling Equipment	10
2.2	Estimate of Average Work-Hours Required for Regulation Compliance by Task and Monitoring Activity	12
2.3	Operating and Maintenance Costs of Sampling	14
2.4	Transport Costs for Sampling	15
2.5	Requirements for Flow Measurement Under The Pulp and Paper Sector Monitoring Regulation	17
2.6	Estimated Costs for Flow Measurement Devices	19
2.7	Laboratory Test Prices for Analytical Test Groups	20
2.8	Operating Costs for Analytical Requirements	24
2.9	Annual Operating Cost of Toxicity Testing	28
2.10	Estimates of Reporting Costs	30
2.11	Potential Costs of Intake Monitoring	31
2.12	Summary of Estimated Capital Costs	33
2.13	Summary of Estimated Operating and Maintenance Costs	35
2.14	Summary of Total Costs Related to the Monitoring Regulation	36

2.15	Pre-Regulation Costs to Industry in the Pulp and Paper Sector	37
2.16	Operating Costs for Alternative Analytical Requirements	39
3.1	Selected Financial Statistics	43
3.2	Summary of Costs Related to the Monitoring Regulation by Firm	48
3.3	Projected Differences in the Rates of Return on Capital Employed as a Result of the Estimated Operating Costs of Monitoring	49
3.4	Summary Impact of Monitoring Costs on Selected Financial Indicators	51

ABSTRACT

- Estimates of the incremental costs to Ontario's pulp and paper mills who are direct dischargers subject to the MISA Monitoring Regulation are derived and summarized.

- Twenty-seven pulp and paper mills in Ontario which are owned by 16 companies are subject to the MISA Monitoring Regulations.

- Capital and operating and maintenance (O & M) costs are estimated by firm for each of five key monitoring activities:

  - sampling requirements (including costs associated with the transport of effluent samples from mills to labs)
  - flow measurement
  - chemical analyses
  - toxicity testing
  - reporting

- Capital costs are estimated to be $3.7 million ± $924,000 using a ± 25% confidence measure.

  - Flow measurement devices account for 76% of total capital costs, sampling equipment accounts for 22%, and reporting requirements account for the remaining 2%.

- Operating and maintenance costs over the 12-month period of the regulation are estimated to be $5.5 million ± $832,000 using a ± 15% confidence measure.

  - Chemical analysis accounts for 61.2% of the total.

  - Sampling, including transport of effluent samples to labs, accounts for 25.5% of total costs.

  - Of the remaining O & M costs, reporting costs account for 7.3%, toxicity testing for 5.5% and maintenance of flow meters for 0.5%.

- Monitoring requirements for the pulp and paper sector involve process-specific requirements and are dependent, in part, on the number and type of sample points or effluent streams that are currently identified at each mill.

- Nine kraft mills are expected to bear 50% of the total estimated costs to the sector or about $4.6 million. Costs are higher for kraft mills because analytical requirements are more extensive than for other mills by virtue of the chlorinated organic compounds in their effluent.

- Eight sulphite-mechanical mills are expected to bear 23% of total costs; two corrugating mills, 9%; eight deinking-board-fine papers-tissue mills, 18%.

- Total incremental monitoring cost ranges for each mill vary from $134,854 - $183,156 to $943,011 - $1,511,838. After the highest cost mill, the Domtar kraft mill at Red Rock, the next highest range is from $524,509 - $769,982.

- A summary of estimated costs by process category and monitoring activity is presented in Figure 1.

- The estimated costs of chemical analysis requirements are compared to the costs that would result from an alternative monitoring program that would require more frequent testing of process effluent streams.

  - As compared to the cost of chemical analysis of $3.4 million under the actual schedule, the alternative schedule would raise the cost of chemical analysis to about $7.5 million.

- Additional costs that are related to, but not required by, the Monitoring Regulations have been and are expected to be borne by pulp and paper firms.

  - Paper companies report that they incurred about $1.8 million in pre-regulation testing and staff costs.

  - Some mills are likely to monitor intake water in order to calculate net loadings in their wastewater discharges. The additional costs of flow measurement devices and chemical analyses for the monitoring of intake water could total as much as $3.4 million for the sector, although they are more likely to range from $1.0 to $1.5 million.

- The cost estimates are not definitive, but indicate the relative costs among different types of mills and the total costs for individual mills and companies.

- Analyses of financial impacts of selected financial performance indicators for pulp and paper firms indicate that the financial effects appear not to burden significantly any of the firms for which data were available.

  - Estimates of incremental capital costs are compared with actual capital expenditures for each of the past seven years for each of 12 firms for which data are available.

  - Incremental O & M costs are computed as a percentage of after-tax profits or earnings for each year for each firm.

  - Calculations are made of the degree of which incremental O & M costs, adjusted to account for the corporate tax rate, would reduce each firm's return on capital employed.

- While it is desirable to carry out financial analysis on a mill by mill basis, data were not available at this level operation. Consequently, the analyses are based on publicly available information for the firms that own the mills.

- It is recognized that the pulp and paper industry is quite cyclical and is very sensitive to national and international business conditions.

  - Pulp and paper companies are generally experiencing record levels of sales and earnings.

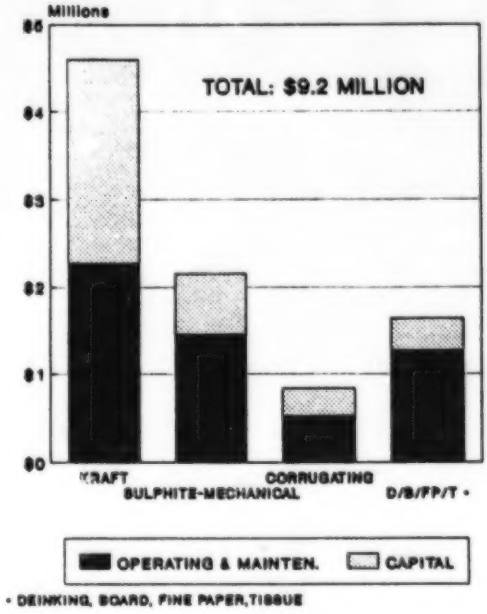
  - Short-term forecasts suggest that 1989 will be another good year.

  - As new production capacity comes on stream in 1990 and beyond, prices and profits are likely to be reduced.

- The cumulative economic impacts of all environmental programs on firms in the industry should be monitored.

Figure 1

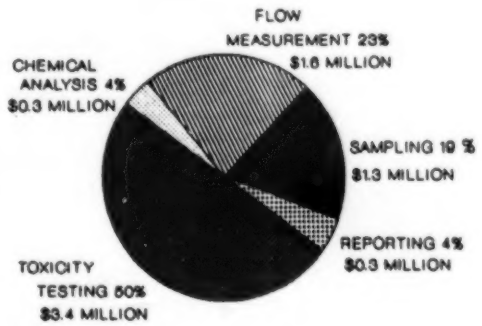
O&M AND CAPITAL COSTS BY CATEGORY



• DEINKING, BOARD, FINE PAPER, TISSUE

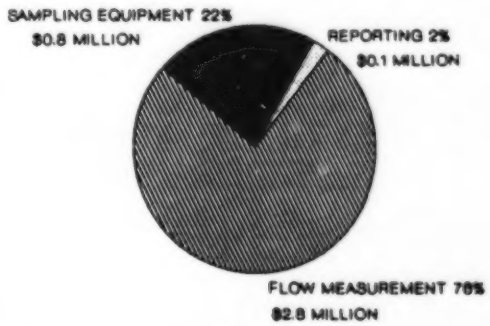
SUMMARY OF ESTIMATED O&M COSTS BY MONITORING FUNCTION

TOTAL: $5.6 MILLION



SUMMARY OF ESTIMATED CAPITAL COSTS BY MONITORING FUNCTION

TOTAL: $3.7 MILLION



SOURCE: TABLES 2.12 AND 2.13

1.0 BACKGROUND AND PURPOSE OF REPORT

1.1 Program Objectives

The Municipal-Industrial Strategy for Abatement (MISA) is intended to achieve the "virtual elimination of toxic contaminants in municipal and industrial discharges into waterways." (Ontario Ministry of the Environment, 1986)

MISA consists of three broad components:

1. Development and promulgation of Regulations which will specify (a) contaminant monitoring requirements, and (b) effluent limits.

2. Development of these effluent limits based on best available technology, economically achievable (BATEA) or water quality impacts.

3. Implementation of abatement programs and enforcement activities.

Economic assessments are a fundamental component of the MISA program. The intent of the economic analyses is to determine the magnitude of the costs and benefits of various regulations and other program elements, reveal the distribution of these costs and benefits, evaluate the economic effects and implications of the potential costs and benefits and where possible, determine the least-cost mechanisms for achieving program objectives (Ontario Ministry of the Environment, 1987a).

1.2 Sectors Affected by MISA

Regulations will be developed for all industrial establishments whether they discharge wastewaters directly into lakes and rivers or indirectly via municipal sewer systems. The first elements of the MISA program to be implemented are monitoring regulations on industrial establishments that discharge wastewaters directly into provincial waterways. Table 1.1 lists the industrial sectors for which monitoring regulations are being developed. Approximately 330 plants and mines in the province will be subject to monitoring regulations.

Plants which are not subject to the direct discharge monitoring regulations eventually will be

TABLE 1.1

INDUSTRIAL SECTORS SUBJECT TO MISA DIRECT DISCHARGE REGULATIONS

Industrial Sector	SIC Nos.	Approximate Number of Plants in Ontario	Direct Discharger Plants or Sites under MISA Regulation
Metal Mining and Refining	0111-0619	*	70
Pulp, Paper and Paper Board	2711-2712	41	27
Iron and Steel	2911-2921	57	7
Metal Casting Foundries	2941-2999	300**	12
Petroleum Refineries	3611	7	7
Inorganic and Organic Chemical Manufacturing	3711-3799	840	41***
Electric-Power and AECL	4911	26	26
Non-metallic and structural mineral quarries and plants (e.g., Cement, brick, lime, sand and gravel, dolomite)	062,081-2 351-2, 358-9	3,000**	140

* Unknown

** Approximate number

*** 4 plants in SIC 1800-1897 were included in the Organic Chemical Manufacturing Sector for purposes of the MISA Monitoring Regulation.

required to implement additional monitoring under a comprehensive sewer use program (Ontario Ministry of the Environment, 1988).

1.3 Effluent Monitoring Regulation for Ontario's Pulp and Paper Sector

The first phase of the MISA regulatory program is the promulgation of monitoring regulations for all plants or establishments within each industrial sector which discharge wastewaters directly into the natural environment. The proposed monitoring regulation for Ontario's pulp and paper mills constitute the basis of this report.

Sixteen firms with 27 Ontario mill locations in this sector are subject to the regulation. For purposes of the MISA program, the mills were categorized by process categories (Ontario Ministry of the Environment, 1989a). The mills are listed by company in Table 1.2.

Monitoring requirements for the pulp and paper mills are specified in two regulations:

1. "Effluent Monitoring - General" which specifies common sampling, analysis, toxicity testing, flow measurement, recording and reporting protocols and procedures for all MISA sectors; and

2. "Effluent Monitoring - Pulp and Paper Sector" which defines monitoring requirements specific to the pulp and paper sector.

The monitoring requirements specified in the Regulations have been developed through negotiations with industry representatives and with representatives from the federal government through a Joint Technical Committee (JTC).

The "Effluent Monitoring - General" regulation came into force June 7, 1988 and will continue to apply to each industrial sector (Government of Ontario, 1988).

The pulp and paper sector regulation will come into force five months after it is promulgated and will continue in effect during the subsequent 12-month period. It will be terminated at the end of the 17-month period. Many monitoring activities will then terminate under a "listing/delisting"

TABLE 1.2

ONTARIO PULP AND PAPER MILLS
SUBJECT TO MISA MONITORING REGULATIONS

	Company	Location	Process Category
1.	Abitibi-Price Inc., Thunder Bay Division	Thunder Bay	S/M
	Abitibi-Price Inc., Fort William Division	Thunder Bay	S/M
	Abitibi-Price Inc., Fine Paper Division	Thunder Bay	S/M
	Abitibi-Price Inc., Iroquois Falls Division	Iroquois Falls	S/M
2.	Beaver Wood Fibre Co. Ltd. (1)	Thorold	B
3.	Boise Cascade Canada Ltd.	Fort Frances	K
	Boise Cascade Canada Ltd.	Kenora	S/M
4.	Canadian Pacific Forest Products Ltd. (2)	Dryden	K
	Canadian Pacific Forest Products Ltd. (2)	Thunder Bay	K
5.	Domtar Inc., Fine Papers Division	Cornwall	K
	Domtar Inc., Containerboard Division	Red Rock	K
	Domtar Inc., Containerboard Division	Trenton	C
	Domtar Inc., Fine Papers Division	St. Catharines	FP
6.	E.B.Eddy Forest Products Ltd. (3)	Espanola	K
	E.B.Eddy Forest Products Ltd. (3)	Ottawa	FP
7.	Fraser Inc. (4)	Thorold	D
8.	James River-Marathon Ltd. (5)	Marathon	K
9.	Kimberly-Clark of Canada Limited	Terrace Bay	K
	Kimberly-Clark of Canada Limited	St. Catharines	T
	Kimberly-Clark of Canada Limited	Huntsville	T
10.	MacMillan Bloedel Limited	Sturgeon Falls	C
11.	Paperboard Industries Corporation (6)	Trenton	B
12.	Quebec & Ontario Paper Company Ltd. (7)	Thorold	S/M
13.	St Marys Paper Inc.	Sault Ste. Marie	S/M
14.	Spruce Falls Power and Paper Company Limited (8)	Kapuskasing	S/M
15.	Strathcona Paper Company (9)	Napanee	B
16.	Waferboard Corporation Ltd. (10)	Smooth Rock Falls	K

NOTES:
(1) Owned by Georgia-Pacific Corporation
(2) Previously, Great Lakes Forest Products Limited
(3) Owned by George Weston Limited via Eddy Paper Company Limited
(4) Owned by Noranda Inc. via Noranda Forest Inc.
(5) Owned by James River Corporation
(6) Trent Valley Paperboard Mills Division
(7) Owned by Tribune Corporation
(8) Jointly owned by Kimberly-Clark and the New York Times
(9) A Division of Roman Corporation Limited
(10) Malette Kraft Pulp and Power Division; Shareholders have voted to change the corporate name to Malette Inc.

Mill Process Category: K - Sulphate (Kraft); S/M - Sulphite/Mechanical C - Corrugating; and Deinking-Board-Fine Papers-Tissue Category, consisting of: B - Board, D - Deinking, FP - Fine Papers, and T - Tissue.

Source: Ontario Ministry of the Environment (1989a)

protocol while some monitoring requirements will be specified in a subsequent "Effluent Limits Compliance Regulation" for this sector.

1.4 Purpose and Objectives of Present Report

This report is intended to present estimates of the potential incremental costs to each of the pulp and paper mills in Ontario which are subject to the requirements of the sector monitoring regulation. The report will also present estimates of certain costs under an alternative scenario in order to test the cost-effectiveness of the requirements. Cost-effectiveness implications have been among the factors considered in arriving at the agreed-to protocols and requirements (Ontario Ministry of the Environment, 1989a, Part II).

This report also provides estimates of the economic and financial effects of the monitoring costs on the Ontario pulp and paper industry, and where possible, on individual firms. Financial data are not always available for specific plants, and the resulting analyses reflect this limitation.

A review of the physical and economic dimensions of the pulp and paper industry in Canada and Ontario may be found in Woods Gordon (1987). Data from this report were used in the analyses found in Chapter 3. Information about individual mills may be found in the "Development Document" for this regulation (Ontario Ministry of the Environment, 1989a, Part II, Appendix I).

1.5 Cost Estimation Methods

Incremental costs of monitoring consist of recurring **operating and maintenance** costs and one time **capital and installation** costs. In this report, capital and operating costs have been estimated for each monitoring function at each paper plant.

Steps involved in cost estimation include postulation of the activities, procedures and resource requirements which are required to implement each monitoring function specified in the regulation, subject to simplifying assumptions where necessary.

Single-valued or point estimates of costs are presented but they should be treated with caution.

Inputs required for different types of monitoring functions are often uncertain and there is some flexibility as to how individual plants may implement the various monitoring requirements. Estimates of capital costs are invariably subject to contingencies, error and uncertainty.

For the above reasons, ranges of capital and operating costs are presented for some monitoring functions.

All cost estimates are expressed in 1988 dollars.

Cost-effectiveness of the monitoring requirements has been examined by comparing the costs associated with the proposed plant and wastewater stream-specific requirements to potential costs incurred under a system in which all mills must carry out the same tests as currently required but more frequently.

2.0 MONITORING REQUIREMENTS AND COST ESTIMATES

2.1 Monitoring Functions

The ("General" and "Pulp and Paper") Effluent Monitoring Regulations specify requirements for five major monitoring activities which each wastewater discharger must implement to various degrees and levels of effort.

1. Sampling
2. Flow measurement
3. Analytical (characterization and routine analyses)
4. Toxicity testing
5. Reporting

In addition, the General Regulation specifies sampling, analytical and reporting protocols which must be followed by all industrial sectors.

Six types of effluent streams or "sampling points" are defined in the regulation:

1. Process effluent
2. Cooling water effluent
3. Waste disposal site effluent
4. Emergency overflow effluent
5. Backwash effluent
6. Storm water

The 27 mills have 44 sampling points, excluding storm water effluents. The number of sampling points is subject to change, as mills may apply for and gain approval to combine effluent streams for testing.

The MISA monitoring requirements for the pulp and paper sector provide for different testing schedules according to the type of effluent stream and the manufacturing processes used at each mill. Process effluent streams at different mills that utilize identical manufacturing or pulping processes must test for the same compounds and at the same frequency.

MISA monitoring requirements differ by sector. In the petroleum refining sector, each plant must test for the same compounds at similar frequencies. In contrast, plant and stream-specific monitoring requirements were developed for the organic chemical sector. While pulp and paper mills are

not all subject to the same monitoring schedule, those mills using the same manufacturing processes are treated identically.

2.2 Sampling

Sampling protocols and specifications are defined in Section 3 of the "Effluent Monitoring - General" Regulation.

This function involves taking water samples from designated sampling points under prescribed procedures and conditions, storing samples under refrigeration where necessary and transporting samples to lab facilities within a prescribed time period. Samples must be taken to perform characterization and routine analyses and biological toxicity tests.

Samples may be taken by hand under the prescribed frequency or by means of automatic sampling equipment. By whatever means they are collected, samples must then be taken to a facility for preparation and, if necessary, for refrigerated storage.

Pulp and paper mills in Ontario are currently collecting samples on a daily basis. It is, therefore, not anticipated that the additional sampling required by this regulation will necessitate the acquisition of any additional vehicles for the collection of samples.

Samples will have to be taken either directly to a commercial laboratory or to a site from which they can be transported to the laboratory.

The regulations further require that samples be stored at a temperature no higher than 10°C, and they must be prevented from freezing. Therefore, each plant will require refrigeration equipment to store samples.

Automatic composite sampler installation must house a refrigerated sample holder in an insulated housing to protect from freezing. The cost of these units is usually included in the capital and installation costs of the automatic samplers.

Automatic flow-proportional samplers, including refrigeration equipment, cost between $7,000 and $10,000. Installation costs, which include temperature recorders, electrical supply, signal

cables and construction, are sensitive to site-specific circumstances and are generally more than twice the equipment cost.

Table 2.1 indicates which mills have currently installed automatic flow-proportional sampling devices and sampler refrigerators. Estimates of the capital and installation cost for sampling devices which were provided by each company are also listed.

Sampling installations and their costs have been identified for both chemical and toxicity sampling. Total capital investments for these facilities were estimated at amount to $817,700 of which 48% will be incurred by kraft mills.

Of the 9 mills which are reported by Canviro (1988), to have automatic samplers installed, all but two report that they will incur further capital costs for these facilities. All mills for which no added capital costs are reported in Table 2.1 are assumed to require no extra costs to comply with MISA monitoring requirements.

Operating costs for sampling are based on estimates of effort for this and other monitoring activities which are summarized in Table 2.2. The person-hours of effort presented in this Table are adjusted at each mill according to the number and type of effluent streams. For monthly reporting and for preparation of the initial report (Tasks 4 and 5 in Table 2.2), the required number of person-hours of effort is assumed to be independent of differences in the number and type of effluent streams. For the other tasks, industry representatives suggested that the number of working hours would increase above the amount specified in Table 2.2 by 50% for each additional process effluent and by 2% for each other type of effluent or sampling point. For example, a mill with two process effluents and three other types of effluents would have an adjustment factor of 156% applied to the figure in Table 2.2.

The 27 Ontario pulp and paper mills are currently expected to monitor 31 process effluent streams, 11 cooling water effluent streams, one backwash effluent stream, one waste site effluent stream and 55 storm water discharge streams. (Ontario Ministry of Environment, 1989b, Appendix 1; repeated as the first column of Table 2.8 below). Based on the adjustments described above, the

TABLE 2.1

SAMPLING AND REFRIGERATION DEVICES CURRENTLY INSTALLED AND COST ESTIMATES FOR ADDITIONAL SAMPLING EQUIPMENT

Company - Mill	FLOW-PROPORTIONAL SAMPLING DEVICES IN PLACE	REFRIGERATED SAMPLING DEVICES IN PLACE	ESTIMATED INSTALLED COST OF ADDITIONAL SAMPLING EQUIPMENT	
			ANALYTICAL	TOXICITY
			(IN 1000'S OF DOLLARS)	
SULPHATE (KRAFT) CATEGORY				
Boise Cascade - Fort Frances	0	0	$20.0	$10.0
Canadian Pacific Forest Products - Dryden	0	0	8.0	
Canadian Pacific Forest Products - Thunder Bay	1	2	100.0	
Domtar Inc. - Cornwall	0	0	90.0	
Domtar Inc. - Red Rock	3	2	60.0	60.0
E.B.Eddy - Espanola	0	0	1.5	2.0
James River-Marathon Ltd. - Marathon	0	0	30.0	15.0
Kimberly-Clark - Terrace Bay	0	0		
Waferboard Corporation - Smooth Rock Falls	1	1		
SUBTOTAL FOR SULPHATE (KRAFT) CATEGORY:			$309.5	$87.0
SULPHITE-MECHANICAL CATEGORY				
Abitibi-Price - Thunder Bay Division	0	0	$11.0	$8.0
Abitibi-Price - Fort William Division	2	0	12.7	
Abitibi-Price - Fine Paper Division	0	0	16.0	3.0
Abitibi-Price - Iroquois Falls Division	0	0	17.0	2.0
Boise Cascade - Kenora	0	0		
Quebec and Ontario Paper - Thorold	0	1	25.0	
St Marys Paper - Sault Ste. Marie	0	0	45.0	5.0
Spruce Falls Power and Paper Company - Kapuskasing	1	0	19.5	
SUBTOTAL FOR SULPHITE-MECHANICAL CATEGORY:			$146.2	$18.0

...Continued

TABLE 2.1 (Continued)

Company - Mill	FLOW-PROPORTIONAL SAMPLING DEVICES IN PLACE	REFRIGERATED SAMPLING DEVICES IN PLACE	ESTIMATED INSTALLED COST OF ADDITIONAL SAMPLING EQUIPMENT	
			ANALYTICAL	TOXICITY
			(IN 1000'S OF DOLLARS)	
CORRUGATING CATEGORY				
Domtar Inc. - Trenton	0	0	65.0	35.0
MacMillan-Bloedel - Sturgeon Falls	0	0		
SUBTOTAL FOR CORRUGATING CATEGORY:			65.0	35.0
DEINKING-BOARD-FINE PAPERS-TISSUE CATEGORY				
Beaver Wood Fibre Company - Thorold	0	0	8.0	2.0
Domtar Inc. - St Catharines	0	0	9.0	
E.B.Eddy - Ottawa	0	0		
Fraser Inc. - Thorold	0	0	90.0	12.0
Kimberly-Clark - St. Catharines	0	1	16.0	2.0
Kimberly-Clark - Huntsville	1	0		
Strathcona Paper - Napanee	1	0	12.0	6.0
Paperboard Industries Corporation - Trenton	0	0		
SUBTOTAL FOR DEINKING-BOARD-FINE PAPERS-TISSUE CATEGORY:			$135.0	$22.0
TOTAL			$655.7	$162.0

SOURCES: CANVIRO (1987) for Equipment Currently in place; Young, B.J. (November 23, 1988) for cost estimates.

TABLE 2.2

ESTIMATE OF AVERAGE WORK-HOURS REQUIRED
FOR REGULATION COMPLIANCE
BY TASK AND MONITORING ACTIVITY*

TASK	HOURS REQUIRED
Sampling and Flow Measurement	
1. Sample collection, preservation and shipping	984 hours
2. Maintenance of:	
- sampling equipment	400 hours
- flow meter	30 hours
Reporting	
3. Data handling (data review, data entry and verification)	223 hours
4. Monthly reporting to MOE	96 hours
5. Preparation of initial report including selection of laboratory facilities and initial calibration of flow meter.	155 hours
TOTAL TIME:	1,888 hours

* Estimates for a mill with a single process effluent stream and no other sampling points. Procedures to adjust person-hour requirements for mills with additional effluent streams are described in the text.

SOURCE: Young, B.J. (November 7, 1988), personal correspondence on behalf of the Ontario Forest Industries Association.

average additional labour requirement resulting from the Regulation is about **2,092 hours** or **265.5 eight-hour work days** per mill.

Industry representatives advised that the wage rates for these activities would range from about $25 to $36 per hour, inclusive of overhead. They also estimated that 80% of the work would be carried out by staff at the lower end of this range. Consequently, an hourly rate of $30 was used to generate the operation and maintenance costs summarized in Table 2.3.

Based on these assumptions and estimates, operation and maintenance of sampling is expected to total $1.3 million for the period of the regulation. At least 71% of this amount is attributable to sample collection activities. These O & M cost magnitudes appear to be consistent with the difficulties imposed by adverse weather conditions in the winter.

Since laboratory facilities are not available at or nearby many of the mills located in Northern Ontario, it will be necessary for them to ship samples to commercial laboratories in Toronto or Montreal for analysis. As noted, it is assumed that all analyses will be conducted by commercial laboratories. Transportation costs are presented in Table 2.4. They were calculated by using average transport costs incurred by mills during the pre-regulation monitoring program carried out by the industry. An industry representative provided an approximation of $20,250 for total transport costs during the pre-regulation period. Because this figure was quite close to the total of $21,731, reported in Table 2.4, his approach was used to provide an estimate of the total anticipated cost to be incurred by transporting samples.

A monthly cost of $300 per process effluent stream and $200 per cooling water effluent stream was suggested. Large volumes of effluent required for biotoxicity testing account for most of the cost. It was assumed that $25 would be incurred for transport of other types of effluents each month.

TABLE 2.3: OPERATING AND MAINTENANCE COSTS OF SAMPLING

Company - Mill	TOTAL	Maintenance	Collection
SULPHATE (KRAFT) CATEGORY			
Boise Cascade - Fort Frances	$43,181	$12,480	$30,701
Canadian Pacific Forest Products - Dryden	44,842	12,960	31,882
Canadian Pacific Forest Products - Thunder Bay	47,333	13,680	33,653
Domtar Inc. - Cornwall	44,842	12,960	31,882
Domtar Inc. - Red Rock	42,350	12,240	30,110
E.B.Eddy - Espanola	64,771	18,720	46,051
James River-Marathon Ltd. - Marathon	47,333	13,680	33,653
Kimberly-Clark - Terrace Bay	44,011	12,720	31,291
Waferboard Corporation - Smooth Rock Falls	44,842	12,960	31,882
SUBTOTAL FOR SULPHATE (KRAFT) CATEGORY:	$423,504	$122,400	$301,104
SULPHITE-MECHANICAL CATEGORY			
Abitibi-Price - Thunder Bay Division	43,181	12,480	30,701
Abitibi-Price - Fort William Division	63,941	18,480	45,461
Abitibi-Price - Fine Paper Division	43,181	12,480	30,701
Abitibi-Price - Iroquois Falls Division	45,672	13,200	32,472
Boise Cascade - Kenora	42,350	12,240	30,110
Quebec and Ontario Paper - Thorold	41,520	12,000	29,520
St Marys Paper - Sault Ste. Marie	41,520	12,000	29,520
Spruce Falls Power and Paper Company - Kapuskasing	45,672	13,200	32,472
SUBTOTAL FOR SULPHITE-MECHANICAL CATEGORY:	$367,037	$106,080	$260,957
CORRUGATING CATEGORY			
Domtar Inc. - Trenton	44,011	12,720	31,291
MacMillan-Bloedel - Sturgeon Falls	86,362	24,960	61,402
SUBTOTAL FOR CORRUGATING CATEGORY:	$130,373	$37,680	$92,693
DEINKING-BOARD-FINE PAPERS-TISSUE CATEGORY			
Beaver Wood Fibre Company - Thorold	42,350	12,240	30,110
Domtar Inc. - St Catharines	41,520	12,000	29,520
E.B.Eddy - Ottawa	41,520	12,000	29,520
Fraser Inc. - Thorold	41,520	12,000	29,520
Kimberly-Clark - St. Catharines	41,520	12,000	29,520
Kimberly-Clark - Huntsville	42,350	12,240	30,110
Strathcona Paper - Napanee	42,350	12,240	30,110
Paperboard Industries Corporation - Trenton	46,502	13,440	33,062
SUBTOTAL FOR DEINKING-BOARD-FINE PAPERS-TISSUE CATEGORY:	$339,634	$98,160	$241,474
TOTAL	$1,260,547	$364,320	$896,227

SOURCE: Table 2.2, with adjustments for the number of effluent streams (found in Table 2.8). A wage rate of $30 per hour is assumed.

TABLE 2.4: TRANSPORT COSTS FOR SAMPLING

Company - Mill	ESTIMATED TRANSPORT COSTS FROM REGULATION	SHIPPING COSTS FOR PRE-REGULATION MONITORING	
		ACTUAL COSTS	PER CENT OF TOTAL
SULPHATE (KRAFT) CATEGORY			
Boise Cascade - Fort Frances	$19,984	$2,800	12.9%
Canadian Pacific Forest Products - Dryden	14,275	2,000	9.2%
Canadian Pacific Forest Products - Thunder Bay	9,992	1,400	6.4%
Domtar Inc. - Cornwall	964	135	0.6%
Domtar Inc. - Red Rock	7,851	1,100	5.1%
E.B.Eddy - Espanola	9,036	1,266	5.8%
James River-Marathon Ltd. - Marathon	3,069	430	2.0%
Kimberly-Clark - Terrace Bay	9,036	1,266	5.8%
Waferboard Corporation - Smooth Rock Falls	7,137	1,000	4.6%
SUBTOTAL FOR SULPHATE (KRAFT) CATEGORY:	$81,343	$11,397	52.4%
SULPHITE-MECHANICAL CATEGORY			
Abitibi-Price - Thunder Bay Division	$4,282	$600	2.8%
Abitibi-Price - Fort William Division	1,427	200	0.9%
Abitibi-Price - Fine Paper Division	4,282	600	2.8%
Abitibi-Price - Iroquois Falls Division	6,281	880	4.0%
Boise Cascade - Kenora	9,992	1,400	6.4%
Quebec and Ontario Paper - Thorold	5,253	736	3.4%
St Marys Paper - Sault Ste. Marie	5,253	736	3.4%
Spruce Falls Power and Paper Company - Kapuskasing	5,253	736	3.4%
SUBTOTAL FOR SULPHITE-MECHANICAL CATEGORY:	$42,024	$5,888	27.1%
CORRUGATING CATEGORY			
Domtar Inc. - Trenton	$357	$50	0.2%
MacMillan-Bloedel - Sturgeon Falls	3,526	494	2.3%
SUBTOTAL FOR CORRUGATING CATEGORY:	$3,883	$544	2.5%
DEINKING-BOARD-FINE PAPERS-TISSUE CATEGORY			
Beaver Wood Fibre Company - Thorold	$4,282	$600	2.8%
Domtar Inc. - St Catharines	8,565	1,200	5.5%
E.B.Eddy - Ottawa	3,526	494	2.3%
Fraser Inc. - Thorold	3,526	494	2.3%
Kimberly-Clark - St. Catharines	3,711	520	2.4%
Kimberly-Clark - Huntsville	0	0	0.0%
Strathcona Paper - Napanee	714	100	0.5%
Paperboard Industries Corporation - Trenton	3,526	494	2.3%
SUBTOTAL FOR DEINKING-BOARD-FINE PAPERS-TISSUE CATEGORY:	$27,850	$3,902	18.0%
TOTAL	$155,100	$21,731	100.0%

SOURCES: Young, B.J., (October 26, 1988) and (November 23, 1988).

Total expected transport costs were then calculated for all effluent streams that are subject to monitoring, using the following formulae:

31 process effluents x $300 x 12	= annual transport cost for process samples
11 cooling water effluents x $200 x 12	= annual transport cost for cooling water effluents
Remaining effluents x $25 x 12	= annual transport cost for remaining effluents

A total transport cost of $155,100 was thus calculated. This total cost was then disaggregated to each mill according to the proportion of actual costs incurred during the pre-regulation period as shown in Table 2.4.

2.3 Flow Measurement

Flow measurement is required to allow accurate calculation of total loadings of contaminants discharged to the environment.

Flow measurement accuracy requirements at each type of sampling point are summarized in Table 2.5.

Based on a study undertaken for the Ministry by CANVIRO (1988), flow measurement devices were rated as acceptable, uncertain or unacceptable. Approximately one third of the mills fell in each category. Ministry and industry representatives agreed that devices rated unacceptable would be replaced, but that those rated uncertain will be accepted if they can be certified as accurate to within $\pm$ 15%. Between six and eighteen mills will need to install flow measurement devices.

Installation costs will vary among mills due to site-specific characteristics such as the volume of effluent flow, location of pipes, etc.

TABLE 2.5

REQUIREMENTS FOR FLOW MEASUREMENT UNDER THE PULP AND PAPER SECTOR MONITORING REGULATION

Outfall Type	Flow Measurement Requirements	Accuracy
Process Effluent	Measured, estimated or calculated	+/- 5% of actual flow using a primary device, +/- 2% of full scale flow using a secondary device Estimate total daily flow if cannot measure flow continuously
Emergency Overflow	Event duration and approximate volume of discharge	+/- 20% of actual flow
Cooling Water Effluent	Measured or estimated flow at time of sampling	+/- 20% of actual flow
Backwash Effluent	Measured or estimated flow at time of sampling	+/- 20% of actual flow
Waste Disposal Site Effluent	Volume and duration of each discharge event	+/- 20% of actual flow
Stormwater	Measured or estimated at time of storm event	+/- 20% of actual flow

NOTE: If existing devices can be proven to have a +/- 15% accuracy, they will be accepted for use in flow measurement.

SOURCE: Pulp and Paper Sector Monitoring Regulation - Section 28, and General Monitoring Regulation - Section 6.

Domtar at Red Rock reported that flow measurement installations would cost an estimated $880,000. The remaining plants submitted estimates ranging from $0 to $250,000 as shown in Table 2.6.

Table 2.6 also includes estimates of the operating and maintenance costs of flow measurement based on the information provided in Table 2.2.

This broad range reflects industry uncertainty regarding potential cost impacts of the flow measurement requirements, and the fact that some mills already have adequate flow measurement devices.

Maintenance costs of flow measurement installations could be substantial in northern locations. Flumes and other devices are vulnerable to clogging with ice in the winter.

2.4 Chemical Analyses

Unlike the MISA monitoring regulations for other industrial sectors, the Pulp and Paper Monitoring Regulation does not distinguish between characterization and routine analyses. Sector characterization and open characterization of organic compounds are treated as part of the routine monitoring schedule.

The Pulp and Paper Monitoring regulation requires that each mill analyze its process streams that discharge into the natural environment for 103 of the 186 chemicals listed on the Effluent Monitoring Priority Pollutants List (EMMPL) on a monthly basis. In addition, each mill will be required to perform an open characterization analysis of organic compounds in each process stream twice during the 12-month period.

It is assumed that characterization and routine chemical analyses as well as biotoxicity tests will be performed by a commercial laboratory, even though some mills may have the ability to conduct many of the analyses on-site. This procedure has been adopted in order to obtain comparable cost estimates for each of the mills.

Costs of chemical analysis for the 12-month period of the regulations are based on the mean commercial laboratory test prices that are listed in Table 2.7. This table derives from a survey of

TABLE 2.6: ESTIMATED COSTS FOR FLOW MEASUREMENT DEVICES

Company - Mill	CANVIRO RATING	CAPITAL COSTS FOR FLOW MONITORING: PROCESS STREAM	CAPITAL COSTS FOR FLOW MONITORING: COOLING STREAM	MAINTENANCE COSTS FOR FLOW METER
SULPHATE (KRAFT) CATEGORY				
Boise Cascade - Fort Frances	UNCER	$200,000	$0	$936
Canadian Pacific Forest Products - Dryden	UNCER	0	200,000	972
Canadian Pacific Forest Products - Thunder Bay	UNACC	105,000	0	1,026
Domtar Inc. - Cornwall	UNCER	210,000	0	972
Domtar Inc. - Red Rock	UNCER	880,000	0	918
E.B.Eddy - Espanola	UNCER	250,000	0	1,404
James River-Marathon Ltd. - Marathon	ACCEP	30,000	20,000	1,026
Kimberly-Clark - Terrace Bay	UNCER	0	0	954
Waferboard Corporation - Smooth Rock Falls	ACCEP	0	0	972
SUBTOTAL FOR SULPHATE (KRAFT) CATEGORY:		$1,675,000	$220,000	$9,180
SULPHITE-MECHANICAL CATEGORY				
Abitibi-Price - Thunder Bay Division	ACCEP	$6,000	$0	936
Abitibi-Price - Fort William Division	UNCER	110,600	0	1,386
Abitibi-Price - Fine Paper Division	UNCER	12,518	30,500	936
Abitibi-Price - Iroquois Falls Division	UNACC	16,700	10,000	990
Boise Cascade - Kenora	ACCEP	0	0	918
Quebec and Ontario Paper - Thorold	UNACC	150,000	0	900
St Marys Paper - Sault Ste. Marie	UNCER	30,000	100,000	900
Spruce Falls Power and Paper Company - Kapuskasing	ACCEP	46,700	0	990
SUBTOTAL FOR SULPHITE-MECHANICAL CATEGORY:		$372,518	$140,500	$7,956
CORRUGATING CATEGORY				
Domtar Inc. - Trenton	UNACC	$200,000	$0	954
MacMillan-Bloedel - Sturgeon Falls	ACCEP	0	0	1,872
SUBTOTAL FOR CORRUGATING CATEGORY:		$200,000	$0	$2,826
DEINKING-BOARD-FINE PAPERS-TISSUE CATEGORY				
Beaver Wood Fibre Company - Thorold	ACCEP	$0	$0	918
Domtar Inc. - St Catharines	UNACC	5,500	0	900
E.B.Eddy - Ottawa	ACCEP	0	0	900
Fraser Inc. - Thorold	UNCER	75,000	0	900
Kimberly-Clark - St. Catharines	UNACC	100,000	0	900
Kimberly-Clark - Huntsville	UNCER	0	0	918
Strathcona Paper - Napanee	UNCER	10,000	0	918
Paperboard Industries Corporation - Trenton	ACCEP	0	0	1,008
SUBTOTAL FOR DEINKING-BOARD-FINE PAPERS-TISSUE CATEGORY:		$190,500	$0	$7,362
TOTAL		$2,438,018	$360,500	$27,324

RATINGS: Acceptable (ACCEP), Uncertain (UNCER), or Unacceptable (UNACC)

SOURCES: CANVIRO (1987), for ratings of flow measurement devices currently in place;
Young, B.J., (November 23,1988), personal correspondance on behalf of the Ontario Forest Industries Association, for capital cost estimates.
Maintenance cost estimates for flow measurement devices are derived from additional labor requirements in Table 2.2, using a wage of $30.00 per hour.

TABLE 2.7

LABORATORY TEST PRICES FOR ANALYTICAL TEST GROUPS

No.	Analytical Test Group	Price ($)			
		Low	Median	Average	High
1.	Chemical Oxygen Demand	14.00	26.00	29.78	70.00
2.	Cyanide	10.00	32.50	36.10	100.00
3.	Hydrogen Ion (pH)	1.30	5.75	6.84	30.00
4a.	Ammonia and Ammonium Nitrogen plus Total Kjeldahl Nitrogen.				
4b.	Nitrate and Nitrite	40.00	55.60	86.99	230.00
5.	Organic Carbon (DOC)	10.00	50.00	57.03	130.00
6.	Total Phosphorus	8.75	20.00	25.12	120.00
7.	Conductivity	2.50	8.00	9.44	45.50
8.	Total Suspended Solids (TSS) Volatile Suspended Solids (VSS)	5.00	13.00	14.87	45.50
9.	Metals (13 metals)	10.00	-	84.10	491.40
10.	Hydrides (Arsenic only)	7.00	20.00	23.33	80.00
11.	Chromium (Hexavalent)	5.00	19.00	20.47	53.30
12.	Mercury	7.00	25.75	25.77	85.00
13.	Total Alkyl Lead	39.00	93.75	172.00	420.00
14.	Phenolics (4AAP)	19.50	35.00	42.93	130.00
15.	Sulphide	-	-	30.00	-
16.	Volatiles, Halogenated	83.00	226.25	239.90	1,020.50
17.	Volatiles, Non-Halogenated	85.00	200.00	176.81	435.50
18.	Volatiles, Water Soluble	50.00	195.00	126.50	325.00

TABLE 2.7 (Continued)

LABORATORY TEST PRICES FOR ANALYTICAL TEST GROUPS

No.	Analytical Test Group	Price ($)			
		Low	Median	Average	High
19	Extractables, Base Neutral	100.00	355.00	427.49	1,560.00
20.	Extractables, Acid (Phenolics)	65.00	260.00	245.68	780.00
21.	Extractables, Phenoxy Acid Herbicides	85.00	185.00	188.09	360.00
22.	Extractables, Organo-chlorine Pesticides	100.00	205.00	270.14	975.00
23.	Extractables, Neutral Chlorinated	105.00	200.00	232.04	900.00
24.	PCDDs & PCDFs	325.00	1,000.00	1,228.27	2,600.00
25.	Oil & Grease	15.00	30.00	36.00	125.00
26.	Fatty Acids & Resins	15.00	143.75	133.18	350.00
27.	PCBs (Total)	40.00	105.00	103.90	240.00
28.	Open Characterizations	-	-	550.00	-
	Supplemental Test Groups for the Pulp and Paper Sector				
	PP1: Biochemical Oxygen Demand (BOD_5)	-	-	25.00	-
	PP2: Adsorbable Organic Halide (AOX)	-	-	250.00	-
	PP4: Dichlorodehydro-abietic Acid	Assumed to impose no additional costs when carried out together with ATG26			

Source: Derived from data in M.M. Dillon (1988), and subsequent telephone survey results reported by Laboratory Services Branch staff.

laboratories in Ontario, Quebec and the U.S. (MOE, Laboratory Services Branch, 1988). The 27 test groups listed contain about 150 individual chemicals. However, effluent samples from Pulp and Paper mills will not be tested for all of the chemicals. Other tests are added specifically for the Pulp and Paper Sector.

Prices of laboratory tests include quality assurance/quality control (QA/QC) samples and the preparation of required reports. However, the cost of the duplicate tests required by the Regulation is added.

The listed prices may overstate the true costs because volume discounts are likely to apply, given the extent of MISA testing. In addition, the price of testing a single chemical which is part of a larger Analytical Test Group may be less than is indicated as the price for the entire group.

There is also the possibility that the prices may understate the costs. Recent follow-ups to the survey suggest that lab prices may be increasing rapidly in the face of rising demand.

Routine analyses involve testing of samples taken at six frequency levels - daily, three times per week, weekly, monthly, bi-monthly and semi-annually. In addition, sampling points such as emergency overflows are tested on an event basis.

Sections 7 through 11 of the Pulp and Paper Monitoring Regulation specify that all mills must test for a limited number of contaminants in process effluents daily, 3 times weekly, weekly, monthly and semi-annually. Sector characterization is required monthly. Tests for chlorinated dioxins and chlorinated dibenzofurans and open characterization must be made twice a year.

Sections 12 through 15 of the Regulation require additional analyses at different frequencies for each category of mill. Sections 16 and 17 apply to mills which use biological treatment of their effluent and which use, but do not produce, bleached kraft pulp. Sections 18 through 22 delineate the testing of cooling water effluent, waste disposal site effluent, backwash effluent, emergency overflow and stormwater. Because mills use different production processes and have various combinations of other effluent streams, the costs

of chemical analyses will vary substantially among process categories and even among some mills within a category.

The costs of routine analyses at each mill are determined in the following manner:

(a) For each category of mill, the required tests and their frequencies are determined from the general and the relevant specific requirements from Sections 7 through 22 and Appendix A to the Regulation.

(b) The 12-month test costs are estimated for each type of mill from its particular schedule of tests. Allowance is made for duplicate tests required as part of MISA quality control.

(c) Each of the 27 mills is then assigned the appropriate annual cost according to its process category and specifics of its operations.

As seen in Table 2.8, the annual cost of chemical analyses range between $69,153 and $283,168 per mill with a median value of about $98,200. The total point estimate for all 27 mills amounts to $3,393,000 per year. These costs exclude transportation to labs which were estimated in Section 2.2.

The anticipated costs of chemical analyses are considerably higher for kraft mills than for other process categories, averaging $170,735 per mill as compared to $103,143 for the remaining mills. Because of the chlorinated organic compounds in their effluents, analytical requirements for kraft mills are more extensive than for other mills. The greater number and frequency of tests for kraft mills results in a higher cost per mill.

2.5 Toxicity Testing

Biological toxicity testing involves the use of a static 96-hour rainbow trout LC50 mortality test and a 48-hour Daphnia magna (a small invertebrate crustacean) mortality (acute lethality) test.

Process effluent streams and cooling water effluent streams will be tested monthly. However, if three consecutive monthly tests result in no more than five dead trout out of 10 at each effluent concentration, samples need only be collected

TABLE 2.8: OPERATING COSTS FOR ANALYTICAL REQUIREMENTS

Mill:	Effluent Stream	Category	Annual Cost by Test Frequency						TOTAL
			Daily	3/Week	Weekly	Monthly	Bi-Monthly	2/Year	
SULPHATE (KRAFT) CATEGORY									
B-C - Fort Frances:	Final Effluent	K*	22,997	67,480	9,964	54,332	0	1,308	
	Storm Water Effluent (2,7)							930	
	Storm Water Effluent (7)							852	$157,863
CPFP - Dryden:	Final Effluent	K*	22,997	67,480	9,964	54,332	0	1,308	
	Storm Water Effluent (2,4)							1,310	
	Storm Water Effluent (3)							852	
	Storm Water Effluent (1)							852	
	Storm Water Effluent (3,5,7)							1,150	$160,245
CPFP - Thunder Bay:	Final Effluent	K	22,997	67,480	3,360	55,676	0	1,308	
	Clean Water Outfall	CWE				1,740			
	Storm Water Effluent (2)							122	
	Storm Water Effluent (4)							1,310	
	Storm Water Effluent (1,3)							852	
	Storm Water Effluent (5,7)							1,150	
	Storm Water Effluent (7)							852	
	Storm Water Effluent (7,3)							852	$157,699
Domtar Inc. - Cornwall:	Final Effluent	K	22,997	67,480	3,360	55,676	0	1,308	
	Storm Water Effluent (5)							1,100	
	Storm Water Effluent (5)							1,100	
	Storm Water Effluent (7)							852	
	Storm Water Effluent (5)							1,100	$154,973
Domtar Inc. - Red Rock:	Final Effluent	K	22,997	67,480	3,360	55,676	0	1,308	
	Storm Water Effluent (2,3)							930	$151,751
E.B.Eddy - Espanola:	Final Effluent	K*	22,997	67,480	9,964	54,332	0	1,308	
	Clarifier Overflow	K	22,265	62,052	3,360	35,220	0	1,308	
	Storm Water Effluent (2,3)							930	
	Storm Water Effluent (1,3,7)							852	
	Storm Water Effluent (5)							1,100	$283,168
James River-Marathon:	Final Effluent	K	22,997	67,480	3,360	55,676	0	1,308	
	Cooling Water	CWE				1,740			
	Cooling Water	CWE				1,740			
	Storm Water Effluent (2)							122	
	Storm Water Effluent (3)							852	
	Storm Water Effluent (7)							852	
	Storm Water Effluent (1)							852	
	Storm Water Effluent (1,5)							1,150	$158,129
K-C - Terrace Bay:	Comb Alkaline and Acid Sewers	K	22,997	67,480	3,360	55,676	0	1,308	
	Storm Water Effluent (7)							852	
	Storm Water Effluent (3)							852	
	Storm Water Effluent (2)							122	$152,647
Waferboard Corporation:	Final Effluent	K	22,997	67,480	3,360	55,676	0	1,308	
	Waste Disposal Site Effluent	WDSE				7,416			
	Storm Water Effluent (2,3,7)							930	
	Storm Water Effluent (2)							122	
	Storm Water Effluent (7)							852	$160,141
SUBTOTAL FOR SULPHATE (KRAFT) CATEGORY:									$1,536,616

...Continued

TABLE 2.8 (Continued)

Mill:	Effluent Stream	Category	Annual Cost by Test Frequency						Total
			Daily	3/Week	Weekly	Monthly	Bi-Monthly	2/Year	
SULPHITE-MECHANICAL CATEGORY									
A-P - Thunder Bay Division:	Final Effluent	S/M	22,997	25,480	3,360	33,092	0	3,764	
	Storm Water Effluent (3)							852	
	Storm Water Effluent (7)							852	$90,397
A-P - Fort William Division:	Final Effluent	S/M	22,997	25,480	3,360	33,092	11,052	1,308	
	Bark Lagoon Effluent	S/M	22,265	23,052	3,360	20,124	7,368	1,308	
	Storm Water Effluent (1,3,7)							852	
	Storm Water Effluent (1,7)							852	$176,470
A-P - Fine Paper Division:	Final Effluent	S/M	22,997	25,480	3,360	33,092	11,052	1,308	
	Storm Water Effluent (1,5,7)							1,150	
	Storm Water Effluent (7)							852	$99,291
A-P - Iroquois Falls Division:	Final Effluent	S/M	22,997	25,480	3,360	33,092	0	3,764	
	Filter Plant Backwash	BWE				1,632			
	Cooling Water	CWE				1,740			
	Storm Water Effluent (5)							1,100	
	Storm Water Effluent (7)							852	
	Storm Water Effluent (1,2,3)							930	$94,947
B-C - Kenora:	Final Effluent	S/M	22,997	25,480	3,360	33,092	11,052	1,308	
	Storm Water Effluent (1,2,7)							930	$98,219
Quebec and Ontario Paper:	Final Effluent	S/M*	22,997	25,480	9,964	31,748	0	3,764	$93,953
St Marys Paper:	Final Effluent	S/M	22,997	25,480	3,360	33,092	11,052	1,308	$97,289
Spruce Falls Power and Paper:	Final Effluent	S/M	22,997	25,480	3,360	33,092	11,052	1,308	
	Storm Water Effluent (2)							122	
	Storm Water Effluent (2,4)							1,310	
	Storm Water Effluent (2,3)							930	
	Storm Water Effluent (2)							122	
	Storm Water Effluent (7)							852	$100,625
SUBTOTAL FOR SULPHITE-MECHANICAL CATEGORY									$851,191
CORRUGATING CATEGORY									
Domtar Inc. - Trenton:	Final Effluent	C	22,997	25,480	3,360	33,092	0	3,764	
	Storm Water Effluent (2,7)							930	
	Storm Water Effluent (5,6,7)							930	
	Storm Water Effluent (5,7)							1,150	$91,703
M-B - Sturgeon Falls:	Black Liquor Overflow	C	22,997	25,480	3,360	33,092	0	3,764	
	Clean Water Effluent	C	22,265	23,052	3,360	20,124	0	3,764	
	Clarifier Overflow	C	22,265	23,052	3,360	20,124	0	3,764	
	Storm Water Effluent (3,7)							852	
	Storm Water Effluent (5,7)							1,150	
	Storm Water Effluent (7)							852	
	Storm Water Effluent (4)							1,310	$237,987
SUBTOTAL FOR CORRUGATING CATEGORY									$329,690

...Continued

TABLE 2.8 (Continued)

Mill:	Effluent Stream	Category	Annual Cost by Test Frequency						Total
			Daily	3/Week	Weekly	Monthly	Bi-Monthly	2/Year	
DEINKING-BOARD-FINE PAPERS-TISSUE CATEGORY									
Beaver Wood Fibre Company:	Final Effluent	B	22,997	4,200	3,360	33,092	0	3,764	
	Spill Pond Overflow	CWE				1,740			$69,153
Domtar Inc. - St Catherines:	Final Effluent	FP	22,997	4,200	3,360	59,196	0	1,308	$91,061
E.B.Eddy - Ottawa:	Final Effluent	FP	22,997	4,200	3,360	59,196	0	1,308	$91,061
Fraser Inc.:	Final Effluent	D*	22,997	4,200	9,964	57,852	0	1,308	$96,321
K-C - St. Catherines:	Final Effluent	T	22,997	4,200	3,360	59,196	0	1,308	$91,061
K-C - Huntsville:	Final Effluent	T	22,997	4,200	3,360	59,196	0	1,308	
	Storm Water Effluent (2)							122	$91,183
Strathcona Paper:	Final Effluent	B	22,997	4,200	3,360	33,092	0	3,764	
	Cooling Water and Filter Plant BW	CWE				1,740			$69,153
Paperboard Industries Corp:	Final Effluent	B	22,997	4,200	3,360	33,092	0	3,764	
	Cooling Water	CWE				1,740			
	Cooling Water	CWE				1,740			
	Cooling Water	CWE				1,740			
	Cooling Water	CWE				1,740			
	Cooling Water	CWE				1,740			
	Storm Water Effluent (6)							586	$76,699
SUBTOTAL FOR DEINKING-BOARD-FINE PAPERS-TISSUE CATEGORY:									$675,692
TOTAL FOR PULP AND PAPER SECTOR:									$3,393,189

Abbreviations:
B - Board Mill in Deinking/Board/Fine Paper/Tissue Category
BWE - Backwash Effluent
C - Corrugating Mill Category
CWE - Cooling Water Effluent
D - Deinking Mill in Deinking/Board/Fine Paper/Tissue Category
FP - Fine Paper Mill in Deinking/Board/Fine Paper/Tissue Category
K - Sulphate (Kraft) Mill Category
S/M - Sulphite/Mechanical Mill Category
T - Tissue Mill in Deinking/Board/Fine Paper/Tissue Category
WDSE - Waste Disposal Site Effluent

Storm Water Effluent from land on the mill site used for:
(1) Bark storage
(2) Bulk storage and unloading
(3) Chip storage
(4) Coal storage
(5) Waste disposal
(6) Waste paper storage
(7) Wood Storage

* - Indicates biological treatment plant in operation

SOURCE: Ontario Ministry of the Environment (1989a)

quarterly thereafter. This provision does not apply to the Daphnia magna test for process effluent streams which must be carried out monthly, although it does apply to cooling water effluent streams. Monthly testing must resume in the event that six or more trout die for any quarterly test.

Table 2.9 lists the maximum and minimum number of biotoxicity tests that could be required annually at each mill. At least six trout tests, and at most twelve, must be carried out during the year for each test stream of every mill indicated. Twelve daphnia tests must be carried out for each process effluent stream, and between six and twelve daphnia tests must be carried for each cooling water effluent stream.

Toxicity testing costs are based on the following prices for a full dilution series:

Trout:	$360 per test
Daphnia:	$240 per test
	$600 per test

The resulting minimum cost estimates may be too high. Having passed three successive monthly tests, a full dilution series is no longer required for cooling water effluent streams. Because only a single test is carried out with 100% effluent, fewer trout are required which may be less costly.

Collection and transport costs for toxicity tests are included in the previous sections.

Using these prices and the maximum testing schedule of one of each test per month on each eligible outlet, the total cost of this function during the 12-month period amounts to $302,400 as shown in Table 2.9. If the minimum number of toxicity tests were carried out for all mills, the total annual cost for both types of toxicity tests would be $195,840, a difference of $106,560.

2.6 Reporting

Monitoring data will have to be assembled, recorded, stored, and reported to company management and to the Ministry of the Environment.

Data storage and manipulation will require an AT personal computer together with compatible peripherals and software, plus personnel dedicated

TABLE 2.9: ANNUAL OPERATING COST OF TOXICITY TESTING

Mill	NUMBER OF TEST STREAMS PROC	CW	POTENTIAL NUMBER OF TROUT/DAPHNIA TESTS MIN.	MAX	MIN. COST	MAX. COST
SULPHATE (KRAFT) CATEGORY						
Boise Cascade - Fort Frances	1		6 / 12	12	$5,040	7,200
Canadian Pacific Forest Products - Dryden	1		6 / 12	12	$5,040	7,200
Canadian Pacific Forest Products - Thunder Bay	1	1	12 / 18	24	$8,640	14,400
Domtar inc. - Cornwall	1		6 / 12	12	$5,040	7,200
Domtar Inc. - Red Rock	1		6 / 12	12	$5,040	7,200
E.B.Eddy - Espanola	2		12 / 24	24	$10,080	14,400
James River-Marathon Ltd. - Marathon	1	2	18 / 24	36	$12,240	21,600
Kimberly-Clark - Terrace Bay	1		6 / 12	12	$5,040	7,200
Waferboard Corporation - Smooth Rock Falls	1		6 / 12	12	$5,040	7,200
SUBTOTAL FOR SULPHATE (KRAFT) CATEGORY					$61,200	$93,600
SULPHITE-MECHANICAL CATEGORY						
Abitibi-Price - Thunder Bay Division	1		6 / 12	12	$5,040	7,200
Abitibi-Price - Fort William Division	2		12 / 24	24	$10,080	14,400
Abitibi-Price - Fine Paper Division	1		6 / 12	12	$5,040	7,200
Abitibi-Price - Iroquois Falls Division	1	1	12 / 18	24	$8,640	14,400
Boise-Cascade - Kenora	1		6 / 12	12	$5,040	7,200
Quebec and Ontario Paper - Thorold	1		6 / 12	12	$5,040	7,200
St Marys Paper - Sault Ste. Marie	1		6 / 12	12	$5,040	7,200
Spruce Falls Power and Paper Company - Kapuskasing	1		6 / 12	12	$5,040	7,200
SUBTOTAL FOR SULPHITE-MECHANICAL CATEGORY					$48,960	$72,000
CORRUGATING CATEGORY						
Domtar Inc. - Trenton	1		6 / 12	12	$5,040	7,200
MacMillan-Bloedel - Sturgeon Falls	3		18 / 36	36	$15,120	21,600
SUBTOTAL FOR CORRUGATING CATEGORY					$20,160	$28,800
DEINKING-BOARD-FINE PAPERS-TISSUE CATEGORY						
Beaver Wood Fibre Company - Thorold	1	1	12 / 18	24	$8,640	14,400
Domtar Inc. - St Catharines	1		6 / 12	12	$5,040	7,200
E.B.Eddy - Ottawa	1		6 / 12	12	$5,040	7,200
Fraser Inc. - Thorold	1		6 / 12	12	$5,040	7,200
Kimberly-Clark - St. Catharines	1		6 / 12	12	$5,040	7,200
Kimberly-Clark - Huntsville	1		6 / 12	12	$5,040	7,200
Strathcona Paper - Napanee	1	1	12 / 18	24	$8,640	14,400
Paperboard Industries Corporation - Trenton	1	5	36 / 42	72	$23,040	43,200
SUBTOTAL FOR DEINKING-BOARD-FINE PAPERS-TISSUE CATEGORY					$65,520	$108,000
TOTAL FOR PULP AND PAPER SECTOR:					$195,840	$302,400

NOTES: PROC refers to Process effluent streams, and CW refers to Cooling Water effluent streams.
Minimum Cost would result if six trout tests and either twelve daphnia tests for process effluent or six for cooling water effluent are carried out during the year for each test stream.
Maximum Cost would result if twelve trout tests and twelve daphnia tests are carried out during the year for each test stream.

SOURCE: Ontario Ministry of the Environment (1989a)

to perform report generation functions. It is assumed that each mill will require a computer for reporting at a cost of $2,000 to $4,000 per location, which includes peripherals and software.

Cost estimates for reporting, as supplied by industry representatives and shown in Table 2.10, vary from $14,000 up to $21,500. These differences are due largely to the number of process effluent streams for which reporting is required.

Furthermore, a detailed "Initial Report" must be prepared and submitted to the Ministry during the period of the Regulation. This report details the plant layout, flow charts of waste streams, analytical methods used and other data. Industry representatives estimated that each mill would have to devote 155 person-hours in the preparation of these reports at a wage rate of $30 per hour. The total cost for this aspect of the Regulation amounts to $4,650 per mill. Initial reports involve a one-time effort but are classified as an operating cost element and listed in Table 2.10.

2.7 Intake Water

Another potential sampling point is intake water. Although the sector Monitoring Regulation does not require monitoring of intake water, firms which obtain their process water from large lakes and rivers which, in turn, receive contaminants from atmosphere fallout and from wastewater discharges from other municipalities and industrial plants, are currently sampling and testing intake water. Data on intake water quality will permit these firms to determine true net loadings of contaminants generated by the plant.

A mill's intention to conduct intake water monitoring is to be stated in its initial report. If the Ministry Director who is in charge of implementation of the monitoring requirements for the mill accepts the need for testing intake water, then the related costs becomes a legitimate, although optional, component of the MISA program. The data generated by such tests will then be included as part of the MISA database. Because these costs are not explicitly required by the Monitoring Regulations, they are excluded from the summary tables which follow.

In general, plants will test intake water only for those chemicals which they must routinely analyze. Table 2.11 shows intake monitoring costs per plant

TABLE 2.10: ESTIMATES OF REPORTING COSTS

Company - Mill	TOTAL OPERATING COSTS FOR REPORTING	DATA HANDLING	MONTHLY REPORTING	INITIAL REPORT(*)
SULPHATE (KRAFT) CATEGORY				
Boise Cascade - Fort Frances	$14,488	$6,958	$2,880	$4,650
Canadian Pacific Forest Products - Dryden	14,755	7,225	2,880	4,650
Canadian Pacific Forest Products - Thunder Bay	15,157	7,627	2,880	4,650
Domtar Inc. - Cornwall	14,755	7,225	2,880	4,650
Domtar Inc. - Red Rock	14,354	6,824	2,880	4,650
E.B.Eddy - Espanola	17,966	10,436	2,880	4,650
James River-Marathon Ltd. - Marathon	15,157	7,627	2,880	4,650
Kimberly-Clark - Terrace Bay	14,621	7,091	2,880	4,650
Waferboard Corporation - Smooth Rock Falls	14,755	7,225	2,880	4,650
SUBTOTAL FOR SULPHATE (KRAFT) CATEGORY:	$136,008	$68,238	$25,920	$41,850
SULPHITE-MECHANICAL CATEGORY				
Abitibi-Price - Thunder Bay Division	$14,488	$6,958	$2,880	$4,650
Abitibi-Price - Fort William Division	17,833	10,303	2,880	4,650
Abitibi-Price - Fine Paper Division	14,488	6,958	2,880	4,650
Abitibi-Price - Iroquois Falls Division	14,889	7,359	2,880	4,650
Boise Cascade - Kenora	14,354	6,824	2,880	4,650
Quebec and Ontario Paper - Thorold	14,220	6,690	2,880	4,650
St Marys Paper - Sault Ste. Marie	14,220	6,690	2,880	4,650
Spruce Falls Power and Paper Company - Kapuskasing	14,889	7,359	2,880	4,650
SUBTOTAL FOR SULPHITE-MECHANICAL CATEGORY:	$119,380	$59,140	$23,040	$37,200
CORRUGATING CATEGORY				
Domtar Inc. - Trenton	$14,621	$7,091	$2,880	$4,650
MacMillan-Bloedel - Sturgeon Falls	21,445	13,915	2,880	4,650
SUBTOTAL FOR CORRUGATING CATEGORY:	$36,067	$21,007	$5,760	$9,300
DEINKING-BOARD-FINE PAPERS-TISSUE CATEGORY				
Beaver Wood Fibre Company - Thorold	14,354	$6,824	$2,880	$4,650
Domtar Inc. - St Catharines	14,220	6,690	2,880	4,650
E.B.Eddy - Ottawa	14,220	6,690	2,880	4,650
Fraser Inc. - Thorold	14,220	6,690	2,880	4,650
Kimberly-Clark - St. Catharines	14,220	6,690	2,880	4,650
Kimberly-Clark - Huntsville	14,354	6,824	2,880	4,650
Strathcona Paper - Napanee	14,354	6,824	2,880	4,650
Paperboard Industries Corporation - Trenton	15,023	7,493	2,880	4,650
SUBTOTAL FOR DEINKING-BOARD-FINE PAPERS-TISSUE CATEGORY:	$114,964	$54,724	$23,040	$37,200
TOTAL	$406,418	$203,108	$77,760	$125,550

(*) Although a non-recurring item, the cost of the initial report will be included with Operating Costs in the summary tables which follow.

SOURCE: Additional labor requirements as reported in Table 2.2, using a wage rate of $30 per hour.

TABLE 2-11: POTENTIAL COST OF INTAKE MONITORING

Company - Mill	CAPITAL COSTS FOR FLOW MEASUREMENT DEVICES	CHEMICAL ANALYSIS
SULPHATE (KRAFT) CATEGORY		
Boise-Cascade - Fort Frances		$156,081
Canadian Pacific Forest Products - Dryden	$15,000	156,081
Canadian Pacific Forest Products - Thunder Bay		150,821
Domtar Inc. - Cornwall	40,000	150,821
Domtar Inc. - Red Rock		150,821
E.B.Eddy - Espanola	17,620	156,081
James River-Marathon Ltd. - Marathon		150,821
Kimberly-Clark - Terrace Bay		150,821
Waferboard Corporation - Smooth Rock Falls		150,821
SUBTOTAL FOR SULPHATE (KRAFT) CATEGORY:	$72,620	$1,373,169
SULPHITE-MECHANICAL CATEGORY		
Abitibi-Price - Thunder Bay Division	45,000	88,693
Abitibi-Price - Fort William Division	15,000	97,289
Abitibi-Price - Fine Paper Division	20,000	97,289
Abitibi-Price - Iroquois Falls Division		88,693
Boise Cascade - Kenora		97,289
Quebec and Ontario Paper - Thorold		93,953
St Marys Paper - Sault Ste. Marie	100,000	97,289
Spruce Falls Power and Paper Company - Kapuskasing		97,289
SUBTOTAL FOR SULPHITE-MECHANICAL CATEGORY:	$180,000	$757,784
CORRUGATING CATEGORY		
Domtar Inc. - Trenton	200,000	88,693
MacMillan-Bloedel - Sturgeon Falls		88,693
SUBTOTAL FOR CORRUGATING CATEGORY:	$200,000	$177,386
DEINKING-BOARD-FINE PAPERS-TISSUE CATEGORY		
Beaver Wood Fibre Company - Thorold	10,000	67,413
Domtar Inc. - St Catharines	5,000	91,061
E.B.Eddy - Ottawa		91,061
Fraser Inc. - Thorold		96,321
Kimberly-Clark - St. Catharines	20,000	91,061
Kimberly-Clark - Huntsville		91,061
Strathcona Paper - Napanee		67,413
Paperboard Industries Corporation - Trenton		67,413
SUBTOTAL FOR DEINKING-BOARD-FINE PAPERS-TISSUE CATEGORY:	$35,000	$662,804
TOTAL	$487,620	$2,971,143

NOTE: The potential cost of chemical analysis is assumed to equal the cost of analysis for the most expensive process effluent stream for each mill, from Table 2.8. Fewer tests, at less cost, may be carried out, but each test must be carried out at the same frequency as the mill's process effluent stream.

SOURCES: Ontario Ministry of the Environment (1989b), Young, B.J. (November 23, 1988) and Table 2.8.

including the cost of intake flow measurement devices as provided by the mills. Assuming that intake water monitoring occurs at the same schedule as the most expensive process effluent stream for each mill, analytical costs for intake water monitoring could range from about $67,400 to $156,100 per plant per year, and as much as $3.0 million for the Pulp and Paper sector as a whole.

The cost of chemical analyses for intake water monitoring is likely to be considerably less than $3.0 million. First, industry representatives report that perhaps half the mills might eventually monitor intake water. If it is assumed that only those mills that have indicated a need for flow measurement devices will test intake water, then the cost of chemical analyses would drop to $1.2 million if all tests are carried out.

Second, it is not likely that all tests required for the process effluent stream would be carried out for intake water. Sampling frequency for intake water monitoring must be the same as the frequency required for the compound or parameter in the monitoring regulation, but not all compounds must be monitored. Consequently, a more realistic estimate of the total cost of intake water monitoring is from $1.0 to $1.5 million. Because intake monitoring is not required, these costs should not be attributed directly to the monitoring regulation.

2.8 Total Estimated Costs of the MISA Pulp and Paper Sector Monitoring Requirements

Table 2.12 presents a summary of the point estimates of capital costs for each monitoring function by mill. These estimates, which were provided by the industry association and have not been analyzed independently, are subject to uncertainties and contingencies and are said to be accurate to within plus or minus 25 percent. Three Domtar mills have reported the highest estimated capital costs, including one mill with a total of over $1 million for flow measurement and sampling installations. Apart from that one mill, estimates of total capital costs range from $3,000 to $303,000 per mill. The median capital cost for the sector is $69,200, while the mean is $136,934.

TABLE 2.12: SUMMARY OF ESTIMATED CAPITAL COSTS (IN $1,000'S)

Company - Mill	TOTAL CAPITAL COSTS	CAPITAL COST OF SAMPLING EQUIPMENT	CAPITAL COST OF FLOW MEASUREMENT DEVICES	CAPITAL COSTS FOR REPORTING
SULPHATE (KRAFT) CATEGORY				
Boise Cascade - Fort Frances	$233.0	$30.0	$200.0	$3.0
Canadian Pacific Forest Products - Dryden	$211.0	8.0	200.0	3.0
Canadian Pacific Forest Products - Thunder Bay	$208.0	100.0	105.0	3.0
Domtar Inc. - Cornwall	$303.0	90.0	210.0	3.0
Domtar Inc. - Red Rock	$1,003.0	120.0	880.0	3.0
E.B.Eddy - Espanola	$256.5	3.5	250.0	3.0
James River-Marathon Ltd. - Marathon	$98.0	45.0	50.0	3.0
Kimberly-Clark - Terrace Bay	$3.0	0.0	0.0	3.0
Waferboard Corporation - Smooth Rock Falls	$3.0	0.0	0.0	3.0
SUBTOTAL FOR SULPHATE (KRAFT) CATEGORY:	$2,318.5	$396.5	$1,895.0	$27.0
SULPHITE-MECHANICAL CATEGORY				
Abitibi-Price - Thunder Bay Division	$28.0	$19.0	$6.0	$3.0
Abitibi-Price - Fort William Division	$126.3	12.7	110.6	3.0
Abitibi-Price - Fine Paper Division	$65.0	19.0	43.0	3.0
Abitibi-Price - Iroquois Falls Division	$48.7	19.0	26.7	3.0
Boise Cascade - Kenora	$3.0	0.0	0.0	3.0
Quebec and Ontario Paper - Thorold	$178.0	25.0	150.0	3.0
St Marys Paper - Sault Ste. Marie	$183.0	50.0	130.0	3.0
Spruce Falls Power and Paper Company - Kapuskasing	$69.2	19.5	46.7	3.0
SUBTOTAL FOR SULPHITE-MECHANICAL CATEGORY:	$701.2	$164.2	$513.0	$24.0
CORRUGATING CATEGORY				
Domtar Inc. - Trenton	$303.0	$100.0	$200.0	$3.0
MacMillan-Bloedel - Sturgeon Falls	$3.0	0.0	0.0	3.0
SUBTOTAL FOR CORRUGATING CATEGORY:	$306.0	$100.0	$200.0	$6.0
DEINKING-BOARD-FINE PAPERS-TISSUE CATEGORY				
Beaver Wood Fibre Company - Thorold	$13.0	$10.0	$0.0	$3.0
Domtar Inc. - St Catharines	$17.5	9.0	5.5	3.0
E.B.Eddy - Ottawa	$3.0	0.0	0.0	3.0
Fraser Inc. - Thorold	$180.0	102.0	75.0	3.0
Kimberly-Clark - St. Catharines	$121.0	18.0	100.0	3.0
Kimberly-Clark - Huntsville	$3.0	0.0	0.0	3.0
Strathcona Paper - Napanee	$31.0	18.0	10.0	3.0
Paperboard Industries Corporation - Trenton	$3.0	0.0	0.0	3.0
SUBTOTAL FOR DEINKING-BOARD-FINE PAPERS-TISSUE CATEGORY:	$371.5	$157.0	$190.5	$24.0
TOTAL	$3,697.2	$817.7	$2,798.5	$81.0

SOURCES: Derived from Tables 2.1 and 2.6, with reporting costs based on the acquisition of one computer per mill.

Flow measurement devices account for $2.8 million of the total estimated capital costs of $3.7 million. The nine kraft mills account for 63% of the estimated capital cost estimates for the sector.

Table 2.13 presents a summary of the point estimates of operating and maintenance costs for each monitoring function by mill. Estimates supplied by the industry association are assumed to be accurate to within plus or minus 15 percent. Estimates of the total operating and maintenance costs associated with the Regulation range from $141,889 to $390,745 per mill, with a median of $174,600 and a mean of $205,370.

The cost of chemical analyses accounts for 61% of the total operating costs, while sampling accounts for 26%. The kraft mills account for $2.3 million of the $5.5 million total operating and maintenance costs for the sector.

Table 2.14 presents a summary of the range of estimates of total capital and operating costs related to the Regulation. Based on the 25 percent margin of accuracy, total capital costs could range from $2.8 million to $4.7 million. Total operating costs are likely to range from $4.9 million to $6.4 million, based on a +/- 15 percent margin of accuracy.

The total cost of compliance with the Regulation is likely to range from $7.5 million to $11.0 million for the sector. The estimates of maximum total costs by mill range from $183,156 to $769,982, apart from the one Domtar mill for which it is estimated to total $1.5 million.

The total costs do not include intake water monitoring, which was discussed in Section 2.7, or the costs to industry related to the development of the Regulation. They are excluded because neither type of cost constitutes a direct burden of the Regulation. However, it is recognized that the costs of intake water monitoring and pre-regulation activities are real costs to the sector. Estimated costs, as provided by the industry association, of pre-regulation monitoring and of time devoted to activities of the Joint Technical Committee are reported in Table 2.15.

TABLE 2.13: SUMMARY OF ESTIMATED OPERATING AND MAINTENANCE COSTS (IN $1,000'S)

Company - Mill	TOTAL OPERATING AND MAINTENENCE COSTS	SAMPLING COSTS		MAINTENANCE COSTS FOR FLOW METER	OPERATING COST FOR ANALYTICAL REQUIREMENTS	TOXICITY TESTING		OPERATING COSTS FOR REPORTING
		O & M	SHIPPING			MIN. COST	MAX. COST	
SULPHATE (KRAFT) CATEGORY								
Boise Cascade - Fort Frances	$243.7	$43.2	$20.0	$0.9	$157.9	$5.0	$7.2	$14.5
Canadian Pacific Forest Products - Dryden	$242.3	44.8	14.3	1.0	160.2	5.0	7.2	14.8
Canadian Pacific Forest Products - Thunder Bay	$245.6	47.3	10.0	1.0	157.7	8.6	14.4	15.2
Domtar Inc. - Cornwall	$223.7	44.8	1.0	1.0	155.0	5.0	7.2	14.8
Domtar Inc. - Red Rock	$224.4	42.4	7.9	0.9	151.8	5.0	7.2	14.4
E.B.Eddy - Espanola	$390.7	64.8	9.0	1.4	283.2	10.1	14.4	18.0
James River-Marathon Ltd. - Marathon	$246.3	47.3	3.1	1.0	158.1	12.2	21.6	15.2
Kimberly-Clark - Terrace Bay	$228.5	44.0	9.0	1.0	152.6	5.0	7.2	14.6
Waferboard Corporation - Smooth Rock Falls	$235.0	44.8	7.1	1.0	160.1	5.0	7.2	14.8
SUBTOTAL FOR SULPHATE (KRAFT) CATEGORY:	$2,280.3	$423.5	$81.3	$9.2	$1,536.6	$61.2	$93.6	$136.0
SULPHITE-MECHANICAL CATEGORY								
Abitibi-Price - Thunder Bay Division	$160.5	$43.2	$4.3	$0.9	$90.4	$5.0	$7.2	$14.5
Abitibi-Price - Fort William Division	$275.5	63.9	1.4	1.4	176.5	10.1	14.4	17.8
Abitibi-Price - Fine Paper Division	$169.4	43.2	4.3	0.9	99.3	5.0	7.2	14.5
Abitibi-Price - Iroquois Falls Division	$177.2	45.7	6.3	1.0	94.9	8.6	14.4	14.9
Boise Cascade - Kenora	$173.0	42.4	10.0	0.9	98.2	5.0	7.2	14.4
Quebec and Ontario Paper - Thorold	$163.0	41.5	5.3	0.9	94.0	5.0	7.2	14.2
St Marys Paper - Sault Ste. Marie	$166.4	41.5	5.3	0.9	97.3	5.0	7.2	14.2
Spruce Falls Power and Paper Company - Kapuskasing	$174.6	45.7	5.3	1.0	100.6	5.0	7.2	14.9
SUBTOTAL FOR SULPHITE-MECHANICAL CATEGORY:	$1,459.6	$367.0	$42.0	$8.0	$851.2	$49.0	$72.0	$119.4
CORRUGATING CATEGORY								
Domtar Inc. - Trenton	$158.8	$44.0	$0.4	$1.0	$91.7	$5.0	$7.2	$14.6
MacMillan-Bloedel - Sturgeon Falls	$372.8	86.4	3.5	1.9	238.0	15.1	21.6	21.4
SUBTOTAL FOR CORRUGATING CATEGORY:	$531.6	$130.4	$3.9	$2.8	$329.7	$20.2	$28.8	$36.1
DEINKING-BOARD-FINE PAPERS-TISSUE CATEGORY								
Beaver Wood Fibre Company - Thorold	$145.5	$42.4	$4.3	$0.9	$69.2	$8.6	$14.4	$14.4
Domtar Inc. - St Catharines	$163.5	41.5	8.6	0.9	91.1	5.0	7.2	14.2
E.B.Eddy - Ottawa	$158.4	41.5	3.5	0.9	91.1	5.0	7.2	14.2
Fraser Inc. - Thorold	$163.7	41.5	3.5	0.9	96.3	5.0	7.2	14.2
Kimberly-Clark - St. Catharines	$158.6	41.5	3.7	0.9	91.1	5.0	7.2	14.2
Kimberly-Clark - Huntsville	$156.0	42.4	0.0	0.9	91.2	5.0	7.2	14.4
Strathcona Paper - Napanee	$141.9	42.4	0.7	0.9	69.2	8.6	14.4	14.4
Paperboard Industries Corporation - Trenton	$186.0	46.5	3.5	1.0	76.7	23.0	43.2	15.0
SUBTOTAL FOR DEINKING-BOARD-FINE PAPERS-TISSUE CATEGORY:	$1,273.5	$339.6	$27.8	$7.4	$675.7	$65.5	$108.0	$115.0
TOTAL	$5,545.0	$1,260.5	$155.1	$27.3	$3,393.2	$195.8	$302.4	$406.4

SOURCES: Tables 2.3, 2.4, 2.6, 2.8, and 2.9.

TABLE 2.14: SUMMARY OF TOTAL COSTS RELATED TO THE MONITORING REGULATION (IN $1,000'S)

Company - Mill	TOTAL COSTS			TOTAL O & M COSTS		TOTAL CAPITAL COSTS	
	MIN.	Point Est.	MAX.	MIN.	MAX.	MIN.	MAX.
SULPHATE (KRAFT) CATEGORY							
Boise Cascade - Fort Frances	$381.9	$476.7	$571.4	$207.1	$280.2	$174.8	$291.3
Canadian Pacific Forest Products - Dryden	364.2	453.3	542.4	205.9	278.6	158.3	263.8
Canadian Pacific Forest Products - Thunder Bay	364.8	453.6	542.4	208.8	282.4	156.0	260.0
Domtar Inc. - Cornwall	417.4	526.7	636.0	190.1	257.3	227.3	378.8
Domtar Inc. - Red Rock	943.0	1,227.4	1,511.8	190.8	258.1	752.3	1,253.8
E.B.Eddy - Espanola	524.5	647.2	770.0	332.1	449.4	192.4	320.6
James River-Marathon Ltd. - Marathon	282.9	344.3	405.8	209.4	283.3	73.5	122.5
Kimberly-Clark - Terrace Bay	196.4	231.5	266.5	194.2	262.7	2.3	3.8
Waferboard Corporation - Smooth Rock Falls	202.0	238.0	274.1	199.8	270.3	2.3	3.8
SUBTOTAL FOR SULPHATE (KRAFT) CATEGORY:	$3,677.1	$4,598.8	$5,520.4	$1,938.2	$2,622.3	$1,738.9	$2,898.1
SULPHITE-MECHANICAL CATEGORY							
Abitibi-Price - Thunder Bay Division	$157.4	$188.5	$219.6	$136.4	$184.6	$21.0	$35.0
Abitibi-Price - Fort William Division	328.9	401.8	474.7	234.1	316.8	94.7	157.9
Abitibi-Price - Fine Paper Division	192.7	234.4	276.1	144.0	194.8	48.8	81.3
Abitibi-Price - Iroquois Falls Division	187.1	225.9	264.6	150.6	203.8	36.5	60.9
Boise Cascade - Kenora	149.3	176.0	202.7	147.1	199.0	2.3	3.8
Quebec and Ontario Paper - Thorold	272.1	341.0	410.0	138.6	187.5	133.5	222.5
St Marys Paper - Sault Ste. Marie	278.7	349.4	420.1	141.4	191.3	137.3	228.8
Spruce Falls Power and Paper Company - Kapuskasing	200.3	243.8	287.3	148.4	200.8	51.9	86.5
SUBTOTAL FOR SULPHITE-MECHANICAL CATEGORY:	$1,766.6	$2,160.8	$2,555.0	$1,240.6	$1,678.5	$525.9	$876.5
CORRUGATING CATEGORY							
Domtar Inc. - Trenton	$362.3	$461.8	$561.4	$135.0	$182.7	$227.3	$378.8
MacMillan-Bloedel - Sturgeon Falls	319.1	375.8	432.5	316.9	428.7	2.3	3.8
SUBTOTAL FOR CORRUGATING CATEGORY:	$681.4	$837.6	$993.9	$451.9	$611.4	$229.5	$382.5
DRINKING-BOARD-FINE PAPERS-TISSUE CATEGORY							
Beaver Wood Fibre Company - Thorold	$133.4	$158.5	$183.5	$123.6	$167.3	$9.8	$16.3
Domtar Inc. - St Catharines	152.1	181.0	209.9	138.9	188.0	13.1	21.9
E.B.Eddy - Ottawa	136.9	161.4	185.9	134.7	182.2	2.3	3.8
Fraser Inc. - Thorold	274.1	343.7	413.2	139.1	188.2	135.0	225.0
Kimberly-Clark - St. Catharines	225.6	279.6	333.7	134.8	182.4	90.8	151.3
Kimberly-Clark - Huntsville	134.9	159.0	183.2	132.6	179.4	2.3	3.8
Strathcona Paper - Napanee	143.9	172.9	201.9	120.6	163.2	23.3	38.8
Paperboard Industries Corporation - Trenton	160.3	189.0	217.6	158.1	213.9	2.3	3.8
SUBTOTAL FOR DRINKING-BOARD-FINE PAPERS-TISSUE CATEGORY:	$1,361.1	$1,645.0	$1,928.9	$1,082.5	$1,464.5	$278.6	$464.4
TOTAL	$7,486.1	$9,242.2	$10,998.2	$4,713.2	$6,376.7	$2,772.9	$4,621.5

SOURCES: Tables 2.12 and 2.13. The assumed margins of error are 25 per cent for capital cost estimates, and 15 per cent for operating and maintenance cost estimates. Columns and rows may not sum to totals due to rounding.

TABLE 2.15

PRE-REGULATION COSTS TO INDUSTRY IN THE PULP AND PAPER SECTOR

Pre-Regulation Monitoring Program	
Sample collection, inorganic chemical analyses and toxicity testing	$ 348,850
Organic chemicals analyses	152,093
Project management	66,905
Sample shipping costs (estimate)	21,731
Mill manpower costs (estimate)	58,348
Other costs absorbed by OFIA	16,669
TOTAL	$ 664,596
Joint Technical Committee and Subcommittees	
Costs invoiced to OFIA[1]	$ 237,687
Total man-days (excluding OFIA)[2] 1650 at $454 per day	749,100
Total expenses (exluding OFIA)	153,372
TOTAL	$1,140,159
Total Pre-Regulation Consultation Phase Cost	

NOTES:

1 Consulting costs invoiced to OFIA for MISA-JTC related work.

2 Man-day costs of $454 were calculated for OFIA by one member company. This analysis has not been reviewed by MOE.

SOURCE:

Young, B.J. (November 7, 1988 and November 23, 1988), personal correspondence on behalf of the Ontario Forest Industries Association.

2.9 Alternative Estimates of Monitoring Costs

The Pulp and Paper Sector Regulation specifies process- and stream-specific testing requirements. The choice of sampling frequencies is discussed in Ontario Ministry of the Environment (January 1989c; Section 2.7). This discussion acknowledges that the choice of sampling frequencies for the various tests, and the corresponding precision of the estimates, must be justifiable in terms of the cost burden imposed on the firms.

This section provides estimates of the additional costs that would be imposed on the sector by increasing the frequency of sampling so that the accuracy and precision of the effluent quality data collected from the mills would be increased. These additional costs, which the sector does not have to bear, reflect a potential saving to industry.

For the alternative schedule, pulp and paper mills are assumed to have only three sampling frequencies for process effluent stream: daily, weekly, and bi-monthly. It is further assumed that there is no change in the schedules for the other effluent streams. In addition, the relationship between the actual schedule and the alternative schedule of testing for process effluent is assumed to be as follows:

Actual Frequency	Alternative Frequency
Daily	Daily
Three times per week	Daily
Weekly	Weekly
Monthly	Weekly
Bi-monthly	Bi-monthly
Semi-annually	Bi-monthly

The results of this exercise, which show only routine and characterization analysis costs, are summarized in Table 2.16. Whereas chemical analysis operating costs shown in Table 2.8 total $3.4 million for the proposed regulation, the alternative frequency schedule would total $7.5 million. The largest burden would be borne by the Kraft mills at $3.6 million under the alternative schedules.

According to MISA staff, the data obtained under the proposed, and less costly, sampling and testing frequencies are sufficient for statistical analysis purposes. (Ontario Ministry of the Environment, 1986c.)

TABLE 2.16: OPERATING COSTS FOR ALTERNATIVE ANALYTICAL REQUIREMENTS

Mill:	Effluent Stream	Process Category	Annual Cost by Test Frequency						TOTAL
			Daily	3/Week	Weekly	Monthly	Bi-Monthly	2/Year	
SULPHATE (KRAFT) CATEGORY									
B-C - Fort Frances:	Final Effluent	K*	178,453	--	178,964	--	0	1,308	
	Storm Water Effluent (2,7)							930	
	Storm Water Effluent (7)							852	$360,506
CPFP - Dryden:	Final Effluent	K*	178,453	--	178,964	--	0	1,308	
	Storm Water Effluent (2,4)							1,310	
	Storm Water Effluent (3)							852	
	Storm Water Effluent (1)							852	
	Storm Water Effluent (3,5,7)							1,150	$362,888
CPFP - Thunder Bay:	Final Effluent	K	178,453	--	178,131	--	0	1,308	
	Clean Water Outfall	CWE				1,740			
	Storm Water Effluent (2)							122	
	Storm Water Effluent (4)							1,310	
	Storm Water Effluent (1,3)							852	
	Storm Water Effluent (5,7)							1,150	
	Storm Water Effluent (7)							852	
	Storm Water Effluent (7,3)							852	$364,769
Domtar Fine Papers - Cornwall:	Final Effluent	K	178,453	--	178,131	--	0	1,308	
	Storm Water Effluent (5)							1,100	
	Storm Water Effluent (5)							1,100	
	Storm Water Effluent (7)							852	
	Storm Water Effluent (5)							1,100	$362,043
Domtar Containerboard - Red Rock:	Final Effluent	K	178,453	--	178,131	--	0	1,308	
	Storm Water Effluent (2,3)							930	$358,821
E.B.Eddy - Espanola:	Final Effluent	K*	178,453	--	178,964	--	0	1,308	
	Clarifier Overflow	K	171,225	--	157,001	--	0	1,308	
	Storm Water Effluent (2,3)							930	
	Storm Water Effluent (1,3,7)							852	
	Storm Water Effluent (5)							1,100	$691,140
James River Marathon:	Final Effluent	K	178,453	--	178,131	--	0	1,308	
	Cooling Water	CWE				1,740			
	Cooling Water	CWE				1,740			
	Storm Water Effluent (2)							122	
	Storm Water Effluent (3)							852	
	Storm Water Effluent (7)							852	
	Storm Water Effluent (1)							852	
	Storm Water Effluent (1,5)							1,150	$365,199
K-C - Terrace Bay:	Comb Alkaline and Acid Sewers	K	178,453	--	178,131	--	0	1,308	
	Storm Water Effluent (7)							852	
	Storm Water Effluent (3)							852	
	Storm Water Effluent (2)							122	$359,717
Waferboard Corporation:	Final Effluent	K	178,453	--	178,131	--	0	1,308	
	Waste Disposal Site Effluent	WDSE				7,416			
	Storm Water Effluent (2,3,7)							930	
	Storm Water Effluent (2)							122	
	Storm Water Effluent (7)							852	$367,211
SUBTOTAL FOR SULPHATE (KRAFT) CATEGORY:									$3,592,295

...Continued

TABLE 2.16 (Continued)

Mill:	Effluent Stream	Category	Annual Cost by Test Frequency						Total
			Daily	3/Week	Weekly	Monthly	Bi-Monthly	2/Year	
SULPHITE-MECHANICAL CATEGORY									
A-P - Thunder Bay Division:	Final Effluent	S/M	56,903	--	107,679	--	0	3,764	
	Storm Water Effluent (3)							852	
	Storm Water Effluent (7)							852	$170,050
A-P - Fort William Division:	Final Effluent	S/M	56,903	--	107,679	--	11,052	1,308	
	Bark Lagoon Effluent	S/M	54,359	--	91,581	--	7,370	1,308	
	Storm Water Effluent (1,3,7)							852	
	Storm Water Effluent (1,7)							852	$333,264
A-P - Fine Paper Division:	Final Effluent	S/M	56,903	--	107,679	--	11,052	1,308	
	Storm Water Effluent (1,5,7)							1,150	
	Storm Water Effluent (7)							852	$178,943
A-P - Iroquois Falls Division:	Final Effluent	S/M	56,903	--	107,679	--	0	3,764	
	Filter Plant Backwash	BWE				1,632			
	Cooling Water	CWE				1,740			
	Storm Water Effluent (5)							1,100	
	Storm Water Effluent (7)							852	
	Storm Water Effluent (1,2,3)							930	$174,600
B-C - Kenora:	Final Effluent	S/M	56,903	--	107,679	--	11,052	1,308	
	Storm Water Effluent (1,2,7)							930	$177,871
Quebec and Ontario Paper:	Final Effluent	S/M*	56,903	--	108,512	--	0	3,764	$169,179
St Marys Paper:	Final Effluent	S/M	56,903	--	107,679	--	11,052	1,308	$176,941
Spruce Falls Power and Paper:	Final Effluent	S/M	56,903	--	107,679	--	11,052	1,308	
	Storm Water Effluent (2)							122	
	Storm Water Effluent (2,4)							1,310	
	Storm Water Effluent (2,3)							930	
	Storm Water Effluent (2)							122	
	Storm Water Effluent (7)							852	$180,277
SUBTOTAL FOR SULPHITE-MECHANICAL CATEGORY									$1,561,125
CORRUGATING CATEGORY									
Domtar Containerboard - Trenton:	Final Effluent	C	56,903	--	107,679	--	0	3,764	
	Storm Water Effluent (2,7)							930	
	Storm Water Effluent (5,6,7)							930	
	Storm Water Effluent (5,7)							1,150	$171,356
M-B - Sturgeon Falls:	Black Liquor Overflow	C	56,903	--	107,679	--	0	3,764	
	Clean Water Effluent	C	54,359	--	91,581	--	0	3,764	
	Clarifier Overflow	C	54,359	--	91,581	--	0	3,764	
	Storm Water Effluent (3,7)							852	
	Storm Water Effluent (5,7)							1,150	
	Storm Water Effluent (7)							852	
	Storm Water Effluent (4)							1,310	$471,920
SUBTOTAL FOR CORRUGATING CATEGORY									$643,276

...Continued

TABLE 2.16 (Continued)

Mill:	Effluent Stream	Category	Annual Cost by Test Frequency						Total
			Daily	3/Week	Weekly	Monthly	Bi-Monthly	2/Year	
DEINKING-BOARD-FINE PAPERS-TISSUE CATEGORY									
Beaver Wood Fibre Company:	Final Effluent	B	32,396	--	168,358	--	0	3,764	
	Spill Pond Overflow	CWE				1,740			$206,258
Domtar Fine Papers-St Catherines:	Final Effluent	FP	32,396	--	190,462	--	0	1,308	$224,165
E.B.Eddy - Ottawa:	Final Effluent	FP	32,396	--	190,462	--	0	1,308	$224,165
Fraser Inc.:	Final Effluent	D*	32,396	--	191,295	--	0	1,308	$224,998
K-C - St. Catherines:	Final Effluent	T	32,396	--	190,462	--	0	1,308	$224,165
K-C - Huntsville:	Final Effluent	T	32,396	--	190,462	--	0	1,308	
	Storm Water Effluent (2)							122	$224,287
Strathcona Paper:	Final Effluent	B	32,396	--	168,358	--	0	3,764	
	Cooling Water and Filter Plant BW	CWE				1,740			$206,258
Paperboard Industries Corp:	Final Effluent	B	32,396	--	168,358	--	0	3,764	
	Cooling Water	CWE				1,740			
	Cooling Water	CWE				1,740			
	Cooling Water	CWE				1,740			
	Cooling Water	CWE				1,740			
	Cooling Water	CWE				1,740			
	Storm Water Effluent (6)							586	$213,804
SUBTOTAL FOR DEINKING-BOARD-FINE PAPERS-TISSUE CATEGORY:									$1,748,101
TOTAL FOR PULP AND PAPER SECTOR:									$7,544,797

Abbreviations:

B - Board Mill in Deinking/Board/Fine Paper/Tissue Category
BWE - Backwash Effluent
C - Corrugating Mill Category
CWE - Cooling Water
D - Deinking Mill in Deinking/Board/Fine Paper/Tissue Category
FP - Fine Paper Mill in Deinking/Board/Fine Paper/Tissue Category
K - Sulphate (Kraft) Mill Category
S/M - Sulphite/Mechanical Mill Category
T - Tissue Mill in Deinking/Board/Fine Paper/Tissue Category
WDSE - Waste Disposal Site Effluent

Storm Water Effluent from land on the mill site used for:
(1) Bark storage
(2) Bulk storage and unloading
(3) Chip storage
(4) Coal storage
(5) Waste disposal
(6) Waste paper storage
(7) Wood Storage

* - Indicates biological treatment plant in operation

SOURCE: Ontario Ministry of the Environment (1989a)

3.0 ECONOMIC EFFECTS AND IMPLICATIONS OF MONITORING COSTS

3.1 Industry Performance

The pulp and paper industry is historically cyclical and is very sensitive to national and international business conditions. Two of the primary products of Ontario mills, market pulp and newsprint, are traded in highly competitive international markets. On the other hand, the world economy is experiencing one of the longest running, non-inflationary economic recovery period in history. Pulp and paper, like other primary industries, has benefitted from the recovery.

Table 3.1 shows current dollar (i.e. unadjusted for inflation) after-tax profits (net income), capital expenditures and return on capital employed each year for the past seven years for 13 companies which own 20 of the mills subject to the MISA monitoring regulation. These data are not complete but they clearly show that most of the firms have registered their highest profits during 1985, 1986 and 1987. Following reduced earnings or losses for many of the firms in 1982 and 1983, performance has been generally very strong. Two firms incurred losses in 1985, but for reasons unrelated to the health of the industry, such as strikes and losses in other unrelated business activities.

Average rates of return on capital employed over the period range from 5% to 13% per company.

These performance indicators and other financial data available in Woods Gordon (1987) were used to evaluate the effects and implications of the MISA monitoring cost estimates on the industry and individual firms.

The recent appreciation of the Canadian dollar relative to the U.S. dollar is likely to weaken the competitive position of Ontario firms. The factor alone is not likely to have substantial short-run impacts on the sector under current market conditions, but, together with scheduled increases in capacity, higher interest rates and economic slowdown, appreciation of the Canadian dollar could impair the economic performance of the industry.

TABLE 3.1: SELECTED FINANCIAL STATISTICS

FIRM	Financial Statistic *	1981	1982	1983	1984	1985	1986	1987	AVERAGE
ABITIBI-PRICE	Net Income	119,641	58,358	38,013	70,138	100,200	107,300	125,700	88,479
	Cap. Expend	195,233	180,411	165,256	126,253	202,400	263,000	256,600	198,450
	ROR on Cap.	11.19%	6.71%	3.93%	7.28%	8.63%	7.71%	7.77%	7.60%
BOISE CASCADE	Net Income**	--	62,663	33,701	103,654	56,549	--	--	64,142
	Cap. Expend	--	41,264	29,960	82,864	164,904	--	--	79,748
	ROR on Cap.	--	--	--	--	--	--	--	--
CANADIAN PACIFIC FOREST PRODUCTS (1)	Net Income	77,774	18,552	(9,936)	17,779	216	30,049	96,185	32,946
	Cap. Expend	189,023	168,765	56,023	47,223	45,108	30,749	52,434	84,189
	ROR on Cap.	16.50%	4.05%	1.27%	6.40%	4.38%	8.09%	15.53%	8.03%
DOMTAR INC.	Net Income	63,556	(1,600)	40,200	93,900	110,400	145,000	161,000	87,494
	Cap. Expend	164,323	168,800	107,700	132,900	284,400	457,100	511,000	260,889
	ROR on Cap.	7.13%	2.88%	6.20%	9.48%	8.67%	8.17%	6.96%	7.07%
FRASER INC.	Net Income	16,183	(4,761)	10,755	3,487	(6,796)	20,600	--	6,578
	Cap. Expend	71,989	114,157	94,966	39,368	22,625	--	--	68,621
	ROR on Cap.	9.04%	2.78%	4.26%	6.04%	5.64%	--	--	5.55%
GEORGE WESTON LIMITED (2)									
- Weston Resources(Forest Products):	Net Income#	33,000	13,000	8,000	40,000	36,000	56,000	68,000	36,286
	Cap. Expend	64,000	100,000	83,000	35,000	28,000	42,000	37,000	55,571
(Fisheries & Forest Products):	ROR on Cap.	15.30%	5.20%	4.70%	11.00%	13.00%	17.80%	18.80%	12.26%
- Consolidated:	Net Income	95,000	69,000	79,000	94,000	101,000	119,000	134,000	98,714
	Cap. Expend	206,000	217,000	245,000	206,000	247,000	390,000	332,000	263,286
	ROR on Cap.	18.10%	14.60%	14.20%	15.20%	15.60%	15.30%	15.10%	15.44%
GEORGIA-PACIFIC CORPORATION (3)	Net Income #	--	118,000	44,000	71,000	202,000	29,000	--	92,800
($ US)	Cap. Expend	--	263,000	65,000	51,000	402,000	435,000	--	243,200
	ROR on Cap.	--	--	--	--	--	--	--	--
KIMBERLY-CLARK: Canadian Operations	Net Income	29,300	17,900	5,400	21,900	17,400	--	--	18,380
($ US)	Cap. Expend	--	--	--	--	--	--	--	--
	ROR on Cap.	--	--	--	--	--	--	--	--
: Total Paper Operations	Net Income #	--	109,200	117,600	139,200	162,100	--	--	132,025
	Cap. Expend	--	41,800	44,400	39,700	35,600	--	--	40,375
	ROR on Cap.	--	--	--	--	--	--	--	--
MACMILLAN-BLOEDEL	Net Income	3,307	(57,300)	23,900	19,300	42,900	178,300	280,600	70,144
	Cap. Expend	307,856	206,800	103,600	137,700	96,600	100,000	--	158,759
	ROR on Cap.	2.07%	-0.87%	5.16%	6.09%	6.77%	10.72%	--	4.99%

...Continued

TABLE 3.1 (Continued)

FIRM	Financial Statistic *	1981	1982	1983	1984	1985	1986	1987	AVERAGE
ROMAN CORPORATION LIMITED (4)	Net Income	15,824	13,128	31,477	23,938	(66,116)	32,536	--	8,465
	Cap. Expend	2,357	4,159	1,199	2,882	2,175	--	--	2,554
	ROR on Cap.	21.64%	13.40%	22.28%	15.79%	-43.08%	4.64%	--	5.78%
SPRUCE FALLS POWER AND PAPER CO.	Net Income	20,313	13,472	7,207	16,876	25,206	--	--	16,615
	Cap. Expend	21,115	15,268	7,792	8,785	7,729	--	--	11,738
	ROR on Cap.	16.73%	12.18%	7.49%	12.31%	14.66%	--	--	12.67%
TRIBUNE CO. (5)	Net Income #	--	13,200	(21,000)	17,900	40,200	--	--	12,575
($ US)	Cap. Expend	--	63,600	13,300	12,900	22,000	--	--	27,950
	ROR on Cap.	--	--	--	--	--	--	--	--
WAFERBOARD CORPORATION (6)	Net Income	541	1,479	929	1,364	1,885	3,626	11,099	2,989
	Cap. Expend	--	--	2,945	6,067	50,205	--	--	19,739
	ROR on Cap.	6.76%	8.02%	8.83%	9.82%	13.18%	--	--	9.32%

Notes: (1) Previously, Great Lakes Forest Products Limited
(2) Owner of E.B.Eddy Forest Products
(3) Owner of Beaver Wood Fibre Co. Ltd.
(4) Of which Strathcona Paper Company is a Division
(5) Owner of Quebec & Ontario Paper Company Limited
(6) Shareholders have voted to change the corporate name to Malette Inc.
* Net Income (ater-tax earnings(losses)) and Capital Expenditures in $ thousands, Rate of Return on Capital Employed (%)
** Pre-Tax Income
# Operating Income

Source: Company Annual Reports; Financial Post Information Services

3.2 Analytical Procedures

Monitoring costs incurred by the firms under the MISA regulations will increase operating expenses and, unless there is some offsetting increase in productivity associated with wastestream monitoring, profits to the firms and returns on particular mills will be reduced. In this section, economic effects of these costs on the industry and on those firms for which financial data are available will be examined.

The approach taken in this analysis will be to estimate how the appropriate incremental monitoring costs would affect historic after-tax profits, capital expenditures and the return on capital employed by each firm. The analysis will show how the monitoring costs would have changed each firm's performance measures if they had been incurred during the worst year over the past 5 years and how they might have affected the average financial performance over the past 3 to 7 years for which relevant data are available. These analyses reveal the extent to which monitoring costs would reduce a company's performance measures below its own historical averages. Morever, comparisons can be made with these same performance measures for the industry as a whole where these are available.

Where long term investment decisions are concerned, a key economic variable is the rate of return on investment or capital employed. This is the return that provides the incentive for owners and investors to remain in a particular enterprise or move on to something else. In this study, the Statistics Canada definition was used in which the ratio is equal to:

$$\frac{\text{After-tax Profits + Interest Payments + Extra-ordinary Expenses}}{\text{Total Assets - Current Liabilities}}$$

Consequently, the first analysis will show how the potentially recurring operating costs of monitoring would have affected the rate of return on capital employed for individual firms and for the industry as a whole.

For this analysis, operating costs of monitoring were first reduced by the amount of the appropriate corporate tax rate because part of these costs are offset by reduced income taxes. The adjusted

incremental operating cost of monitoring was then subtracted from after-tax profits to determine a new rate of return on capital employed. This calculation was carried out for each firm in each year for which data were available. The new rates of return could then be compared with average rates of return for the industry as well as each firm's historical performance records.

A second analysis calculated the proportion that operating costs of monitoring make up of after-tax profits. This indicates what would happen if all operating costs were absorbed by the firm as a reduction in after-tax profits. This calculation yields an over-estimate of the effect because operating costs of monitoring are not reduced by the corporate tax rates as was done in the previous analysis.

A third analytical procedure was carried out to determine the extent to which capital requirements for monitoring would divert capital expenditure away from other uses. Estimated capital costs of monitoring were thus computed as a percent of total capital expenditures for each firm in each year for which capital expenditure data are available. There is no rule of thumb as to what proportion of capital expenditures should be devoted to environmental protection in any given year. Some industrial representatives assert that a minimum capital expenditure is necessary to carry out a sufficient amount of repair and replacement in order to keep a plant running. These basic expenditures apparently vary from industry to industry and from firm to firm.

This comparison of expected capital expenditures to actual outlays is conservative in that it overstates the potential diversion of funds in a given year. Capital costs are normally depreciated over three to five years so that only a proportion of the actual expenditure would be deducted each year, not the full amount that is used in the present analysis.

International competitiveness can be affected by environmental expenditures to the extent that firms may be unable to maintain product quality or pass along cost increases in the face of international market-determined competitive prices. This issue is currently of greater concern to market pulp and newsprint producers who sell to highly competitive international markets than to fine paper, box

board, corrugated and tissue manufacturers which concentrate on domestic markets and which have been protected by tariff barriers.

These analyses are by no means definitive but they can identify those firms which could experience financial effects that are large relative to (a) their own historical performance, (b) other firms' performance, and/or (c) industry performance.

Financial data are seldom available for individual plants although it is at this level where financial consequences can often influence decisions or affect the viability of an operation. Assessments and comparisons will generally have to be made against consolidated company data which are publicly available. For some firms, a limited amount of disaggregated data on the pulp and paper segments of their businesses is published. These data will be used in the analyses rather than consolidated company data where they are available.

Table 3.2 presents a summary of firm of the estimates of total capital and operating and maintenance costs of the Regulation. The plant-specific costs discussed in the previous chapter are aggregated to obtain costs by firm which form the basis for the analyses in the following sectin. The lack of plant-specific financial data dictates that these analyses be carried out at the firm level.

3.3 Economic and Financial Implications

Table 3.3 presents a summary of the percentage reduction in the rate of return on investment that would be imposed on firms for which data are currently available. On average, operating costs of monitoring indicated in Table 3.3, would reduce company rates of return by only 0.01% to 0.2% over the 6 to 7 year period of analysis. The actual rates of return recorded by these companies are shown in Table 3.1.

Looking at the annual results displayed in Table 3.3, the largest effect would be experienced by Waferboard Corp., owner of the Malette kraft mill at Smooth Rock Falls.

TABLE 3.2: SUMMARY OF COSTS RELATED TO THE MONITORING REGULATION BY FIRM (IN $1,000'S)

FIRM	TOTAL CAPITAL COSTS	TOTAL O & M COSTS	TOTAL COSTS		
			MIN.	POINT EST.	MAX.
ABITIBI-PRICE	$268.0	$782.5	$866.1	$1,050.5	$1,234.9
BOISE CASCADE	236.0	416.7	531.2	652.7	774.2
CANADIAN PACIFIC FOREST PRODUCTS (1)	419.0	487.9	729.0	906.9	1,084.8
DOMTAR INC.	1,626.5	770.4	1,874.7	2,396.9	2,919.1
FRASER INC.	180.0	163.7	274.1	343.7	413.2
GEORGE WESTON LIMITED (2)	259.5	549.2	661.4	808.7	955.9
GEORGIA-PACIFIC CORPORATION (3)	13.0	145.5	133.4	158.5	183.5
JAMES RIVER CORPORATION (4)	98.0	246.3	282.9	344.3	405.8
KIMBERLY-CLARK	127.0	543.1	556.9	670.1	783.3
MACMILLAN-BLOEDEL	3.0	372.8	319.1	375.8	432.5
PAPERBOARD INDUSTRIES CORPORATION	3.0	186.0	160.3	189.0	217.6
ROMAN CORPORATION LIMITED (5)	31.0	141.9	143.9	172.9	201.9
ST MARYS PAPER	183.0	166.4	278.7	349.4	420.1
SPRUCE FALLS POWER AND PAPER CO.	69.2	174.6	200.3	243.8	287.3
TRIBUNE CO. (6)	178.0	163.0	272.1	341.0	410.0
WAFERBOARD CORPORATION (7)	3.0	235.0	202.0	238.0	274.1

Notes:
(1) Previously, Great Lakes Forest Products Limited
(2) Owner of E.B.Eddy Forest Products Ltd. via Eddy Paper Company Limited
(3) Owner of Beaver Wood Fibre Co. Ltd.
(4) Owner of James River-Marathon Ltd.
(5) Of which Strathcona Paper Company is a division
(6) Owner of Quebec and Ontario Paper Company Ltd.
(7) Shareholders have voted to change the corporate name to Malette Inc.

Sources: Tables 2.12, 2.13 and 2.14. The assumed margins of error are 25% for capital cost estimates and 15% for operating and maintenance cost estimates.

TABLE 3.3

PROJECTED DIFFERENCES IN THE RATES OF RETURN ON CAPITAL EMPLOYED
AS A RESULT OF THE ESTIMATED OPERATING COSTS OF MONITORING
(DIFFERENCES, IN PER CENT)

MILL	1981	1982	1983	1984	1985	1986	1987	Average
ABITIBI-PRICE	-0.03%	-0.03%	-0.03%	-0.03%	-0.03%	-0.02%	-0.02%	-0.03%
BOISE CASCADE								
CANADIAN PACIFIC FOREST PRODUCTS (1)	-0.06%	-0.05%	-0.05%	-0.05%	-0.05%	-0.05%	-0.04%	-0.05%
DOMTAR INC.	-0.04%	-0.04%	-0.04%	-0.04%	-0.03%	-0.03%	-0.02%	-0.03%
FRASER INC.	-0.03%	-0.02%	-0.02%	-0.02%	-0.02%	--	--	-0.02%
GEORGE WESTON LIMITED (2)	-0.02%	-0.07%	-0.04%	-0.01%	-0.26%	0.04%	-0.04%	-0.06%
GEORGIA-PACIFIC CORPORATION (3)								
JAMES RIVER CORPORATION (4) *								
KIMBERLY-CLARK *								
MACMILLAN-BLOEDEL	-0.01%	-0.01%	-0.01%	-0.01%	-0.01%	-0.01%	--	-0.01%
PAPERBOARD INDUSTRIES CORPORATION *								
ROMAN CORPORATION LIMITED (5)	-0.11%	-0.08%	-0.07%	-0.06%	-0.07%	-0.06%	--	-0.08%
ST MARYS PAPER *								
SPRUCE FALLS POWER AND PAPER CO.	-0.08%	-0.07%	-0.07%	-0.06%	-0.06%	--	--	-0.07%
TRIBUNE CO. (6)								
WAFERBOARD CORPORATION (7)	--	--	-0.26%	-0.24%	-0.22%	-0.20%	-0.12%	-0.21%

Notes: (1) Previously, Great Lakes Forest Products Limited
(2) Owner of E.B.Eddy Forest Products
(3) Owner of Beaver Wood Fibre Co. Ltd.
(4) Owner of James River-Marathon Ltd.
(5) Of which Strathcona Paper Company is a division
(6) Owner of Quebec and Ontario Paper Company Limited
(7) Shareholders have voted to change the corporate name to Malette Inc.
* Insufficient financial data available

Sources: Company Annual Reports; Tables 2.12, 2.13 and 2.14

However, Waferboard Corporation acquired the Malette mills in December, 1986, so that the figures prior to 1987, as well as the average change, are misleading. According to the company's 1988 annual report, kraft bleached pulp from this mill generated about 59% of the company's sales and 73% of its gross profit.

Table 3.4 presents a summary of the effects of expected monitoring costs on after-tax profits (net earnings) and capital expenditures for 10 companies. The monitoring costs used in computing these ratios are the high end of the estimated ranges.

As indicated, percentages are computed for the highest, lowest and average annual net earnings and capital expenditures for the period 1981 to 1987.

During this period, five companies experienced after-tax losses for a single year, while Fraser Inc. experienced after-tax losses in two years.

The addition of monitoring operating costs would have increased the losses incurred in those particular years slightly. During Domtar's worst year, operating costs of monitoring would have increased the after-tax loss by 51% because the loss incurred that year was relatively small. In Waferboard's worst year (which was prior to the acquisition of its pulp and paper operations), after-tax profit would have been reduced by as much as 46.5%.

Monitoring costs have little effect on the remaining firms' net earnings during their worst years. During the companies' best years, and on average, incremental operating costs ranged from less than 0.5% to 8.4% of after-tax profits with the majority in the range of 1.5% or lower.

Table 3.3 also reveals that estimated capital costs of monitoring amount to 3.3% or less of total capital expenditures in any one year over the 1981 to 1987 period for the 13 companies analyzed. Apart from Roman Corporation, estimated capital costs of monitoring are less than 2% of annual capital expenditures in each year. In particular, Domtar Fine Papers estimated that it would invest well over $1 million in capital on monitoring facilities. These amounts would have accounted for only 0.4 to 1.9% of total capital expenditures in any one year.

TABLE 3.4: SUMMARY IMPACT OF MONITORING COSTS ON SELECTED FINANCIAL INDICATORS

FIRM	CAPITAL EXPENDITURES: Monitoring Capital Cost as a % of Annual Capital Expenditure			AFTER-TAX EARNINGS: Monitoring Operating Cost as a % of Annual After-Tax Earnings (Loss)		
	Average Year	Highest Year	Lowest Year	Average Year	Highest Year	Lowest Year
ABITIBI-PRICE	0.17%	0.13%	0.27%	0.90%	0.63%	2.09%
BOISE CASCADE	0.37%	0.18%	0.99%	0.68%	0.42%	1.29%
CANADIAN PACIFIC FOREST PRODUCTS (1)	0.62%	0.28%	1.71%	1.58%	0.54%	-5.25%
DOMTAR INC.	0.78%	0.40%	1.89%	0.93%	0.51%	-51.00%
FRASER INC.	0.33%	0.20%	1.00%	2.69%	0.86%	-2.60%
GEORGE WESTON LIMITED (2)	0.58%	0.32%	1.16%	1.74%	0.93%	7.90%
Weston Resources (Forest Products) (*)	0.12%	0.08%	0.16%	0.64%	0.47%	0.92%
Consolidated Financial Data	0.01%	0.00%	0.03%	0.19%	0.09%	0.61%
GEORGIA-PACIFIC CORPORATION (3,*,#)				3.14%	1.97%	10.69%
JAMES RIVER CORPORATION (4)				0.44%	0.36%	0.53%
KIMBERLY-CLARK: Canadian Operations (#)	0.39%	0.36%	0.45%	0.53%	0.13%	-0.65%
Total Paper Operations (*)	0.00%	0.00%	0.00%			
MACMILLAN-BLOEDEL				2.06%	0.54%	-0.26%
PAPERBOARD INDUSTRIES CORPORATION	1.53%	0.94%	3.25%			
ROMAN CORPORATION LIMITED (5)				1.07%	0.70%	2.46%
ST MARYS PAPER	0.74%	0.41%	1.12%	1.32%	0.41%	-0.79%
SPRUCE FALLS POWER AND PAPER CO.	0.80%	0.35%	1.73%	8.41%	2.27%	46.47%
TRIBUNE CO. (6,*,#)	0.02%	0.01%	0.14%			
WAFERBOARD CORPORATION (7)						

Notes:
(1) Previously, Great Lakes Forest Products Limited
(2) Owner of E.B.Eddy Forest Products Ltd. via Eddy Paper Company Limited
(3) Owner of Beaver Wood Fibre Co. Ltd.
(4) Owner of James River-Marathon Ltd.
(5) Of which Strathcona Paper Company is a division
(6) Owner of Quebec and Ontario Paper Company Ltd.
(7) Shareholders have voted to change the corporate name to Malette Inc.
(*) Calculations based on Pre-tax Income
(#) Financial data reported in $US

Sources: Company Annual Reports; Tables 3.1 and 3.2

As noted earlier, these analyses refer to consolidated financial performance of the firms which own the mills. For only a few of the companies analyzed (e.g., Canadian Pacific Forest Products, Abitibi Price, Spruce Falls Power and Paper Co.) do Ontario pulp and paper mills constitute the major source of income and operational cost. Furthermore, plant-specific profit and loss data are not publicly available. Nevertheless, while the incremental costs of monitoring that will likely be incurred by pulp and paper mills are large in an absolute sense, there is no indication that these expenses will tax the financial capabilities of any of the firms for which financial data are available.

In addition, at this writing, there is no indication that the extra monitoring costs would cause any undue economic difficulties to the firms for which we have no company data.

Finally, costs of the magnitudes being considered do not appear to have any effect on the international competitiveness of these firms.

Monitoring requirements will induce a temporary and not inconsiderable increase in work and construction activity at each mill. Furthermore, demand for laboratory services as well as flow measurement and effluent sampling equipment from this sector will increase during the next two years.

While it is expected that monitoring costs will <u>not</u> impose significant adverse financial effects on the 4 or 5 mills for which financial data are not available (e.g., James River Corp., Paperboard Industries Corp., and St. Mary's Paper), additional data may be made available by individual mills or firms to evaluate financial impacts in more detail.

Two further qualifications regarding the impact of the proposed monitoring costs on the pulp and paper industry are noted.

First, the monitoring costs cited in this report constitute only a part of the environmental protection costs this, and other, industrial sectors will face in Ontario, and elsewhere for that matter. Some of the firms in the pulp and paper industry operate plants in other industrial sectors which are subject to MISA monitoring regulations. Domtar is one such example.

Furthermore, most direct discharger firms will likely face additional costs of further abatement of water, air and solid waste pollutants as new requirements are put in place. Under MISA, effluent limits regulations will be promulgated and regulations concerning air pollution control are being amended which could imply further costs, and opportunities for cost saving in some instances, for industrial plants (Ontario Ministry of the Environment, 1987b).

These cumulative costs burdens may be further increased by regulatory requirements for workplace health and safety and for consumer protection which are administered by other provincial and federal government agencies.

A second qualification has the potential to offset the cost burden to an industry or an individual firm. Depending on market structure of the industry and demand conditions facing Ontario firms, companies will be able to pass on some or all incremental costs in the form of higher prices. The ability to pass on costs also depends on the range of variation regulatory costs which befall each plant or firm.

For example, the pulp and paper industry faces internationally competitive markets for pulp and, for newsprint. There are virtually no tariffs or other impediments for the international movement of these commodities so that firms in Ontario would be limited in passing on extra costs of any kind unilaterally.

On the other hand, Canadian producers of boxboard, corrugated materials, fine papers and tissues have long enjoyed tariff protection and so would have the ability to pass on some additional costs to these product prices.

However, under the free trade agreement, tariffs and any other trade barriers for these products will be reduced gradually over 10 years so that firms will likely face more competitive markets for these products in the future.

The cumulative cost burden and the ability of firms to raise product prices are difficult to determine precisely but imply offsetting effects on each industrial sector which faces regulatory regulatory requirements and costs.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

Conclusions reached in this review are as follows:

(a) Estimated capital costs of the monitoring requirements for mills subject to the MISA Monitoring Regulations range from $2.77 million to $4.62 million. One firm expects to spend over $1 million at the two mills it operates in Ontario. Excluding that mill, capital expenditures range from $3,000 to $303,000 per mills for the 27 mills.

(b) Total estimated operating and maintenance costs are expected to range from $4.71 million to $6.38 million for 27 mills with a point estimate of $5.54 million. Most of this expense is for analytical services which accounts for 61% of operating cost estimates.

(c) Total incremental costs for complying with the regulation range from $7.49 million to $11.00 million. The ranges cited are due to uncertainties and contingencies associated with capital cost estimates, and with some of the operating costs. Excluding the highest cost Domtar mill, point estimates of the total costs per mill range from a low of $159,005 to a high of $647,245.

(d) While the incremental costs of MISA monitoring that will likely be incurred by pulp and paper mills are large in an absolute sense, comparisons with historical after-tax profits (earnings) and capital expenditures data analyses of the effects on the return on capital employed gave no indication that the financial capabilities of the firms in question will be significantly burdened.

(e) The analyses and data presented in this report provide benchmarks for the assessments of future environmental protection costs which may be incurred by this sector.

(f) The cumulative cost burdens of future environmental protection requirements and other regulatory agenda (e.g., workplace health and safety) are likely to grow.

4.2 Recommendations

In order to identify possible problems at an early stage, it is recommended that the Ministry of the Environment and the industry work together to identify the actual incremental capital and operating costs of the monitoring requirements in the early portion of the regulation period. Early identification of possible financial burdens will enable this Ministry and the individual mill to review and assess workable solutions.

Also, at the end of the regulation period, it is recommended that each plant report the actual incremental costs incurred due to the MISA monitoring requirements in order to:

- validate and improve the cost-estimation procedures used in this report.

- monitor and assess the financial and employment impacts of the monitoring requirements.

The cumulative financial burdens of monitoring requirements in other sectors, other MISA requirements, air and solid waste control regulations and regulatory requirements by other federal and provincial agencies should be monitored.

Finally, when monitoring data and activities at these plants (and other industrial dischargers) are audited by Ministry of the Environment personnel or their agents, information should be gathered to determine whether the monitoring activities or data have been, or could be, helpful in making the operations or processes more efficient and productive.

RE FERENCES

Canadian Pulp and Paper Association (Various years). Reference Tables.

Canviro Consultants (1988). Flow Measurement and Sampling Study for the Pulp and Paper Sector in Ontario. Prepared for Ontario Ministry of the Environment.

M.M. Dillon (1988). Inventory and Critical Review of Laboratory Resources. Prepared for Laboratory Services Branch, Ontario Ministry of the Environment.

Government of Ontario (1988). "Regulation Made Under the Environmental Protection Act, Effluent Monitoring - General". (Ontario Regulation 695/88).

Ontario Ministry of the Environment (1986). Municipal-Industrial Strategy for Abatement (MISA): A Policy and Program Statement of the Government of Ontario on Controlling Municipal and Industrial Discharges into Surface Waters.

Ontario Ministry of the Environment (1987a). Economic Information Needs and Assessments for Developing MISA Monitoring and Abatement Requirements.

Ontario Ministry of the Environment (1987b). Stopping Air Pollution at its Source - CAP - Clean Air Program. Discussion Paper.

Ontario Ministry of the Environment (1988). Controlling Industrial Discharges to Sewers.

Ontario Ministry of the Environment (1989a). "The Development Document for the Effluent Monitoring Regulation for the Pulp and Paper Sector." Water Resources Branch.

Woods Gordon Management Consultants (1987). The Economic and Financial Profile of the Ontario Pulp and Paper Sector. Prepared for Policy and Planning Branch, Ontario Ministry of the Environment.

Young, B.J. (October 26, 1988). Personal correspondence on behalf of the Ontario Forest Industries Association.

Young, B.J. (November 7, 1988). Personal correspondence on behalf of the Ontario Forest Industries Association.

Young, B.J. (November 23, 1988). Personal correspondence on behalf of the Ontario Forest Industries Association.